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JOURNAL OF THE ROYAL SOCIETY OF ARTS.

CONTENTS.

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Journal of the Royal Society of Arts.

No. 3,339. VOL. LXV.

FRIDAY, NOVEMBER 17, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

ONE-HUNDRED-AND-SIXTY-THIRD SESSION, 1916-1917.

SESSIONAL ARRANGEMENTS.

The Opening Meeting of the One Hundred and Sixty-Third Session was held on Wednesday, November 15th, when an address was delivered by DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, on "The Stability of Great Britain." (See pp. 5-19, below.) The chair was taken at 4.30 p.m.

PAPERS TO BE READ BEFORE CHRISTMAS.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. (unless otherwise announced):—

NOVEMBER 22.—LESLIE URQUHART, "The Financial Position and Economic Development of Russia." THE RIGHT HON. LORD CARNOCK, G.C.B., G.C.M.G., G.C.V.O., K.C.I.E., British Ambassador in Russia, 1906-1910, will preside.

" 29.—DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, "The Internal-Combustion Engine."

DECEMBER 6.—C. M. WHITTAKER, B.Sc., "The Coal-Tar Colour Industry." SIR WILLIAM A. TILDEN, D.Sc., F.R.S., will preside.

" 13.—H. WILSON FOX, "The Development of Imperial Resources."

" 20 (at 4 p.m.).—A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 14.—JOHN AITON TODD, B.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it."

PAPERS TO BE READ AFTER CHRISTMAS.

LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

J. H. VICKERY, "German Business Methods."

CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

OCTAVIUS C. BEALE, "British Arts and Crafts after the War."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel."

SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

F. A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

January 18, February 15, March 15, April 19, May 17.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

January 30, February 27, March 27, May 1.

HOWARD LECTURES.

Monday afternoons, at 5.0 or 4.30 p.m. (unless otherwise announced):—

JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." Three Lectures. (Five o'clock.)

LECTURE I.—NOVEMBER 27.—The economic importance of coal—Enhanced importance in war time—Coal: the munition of war—The movement for economy—The output of coal and consumption for various purposes—Duration of supplies and economical considerations in relation to other countries—Other alternative sources of energy.

LECTURE II.—DECEMBER 4.—Recent developments in knowledge of composition of coal—Coal as a heating agent—As source of power—For domestic heating, etc.—The by-products from coal distillation, their relation to industry, and particularly as raw materials for munitions of war.

LECTURE III.—DECEMBER 11.—Directions in which economy may be realised—Economy in production—The utilisation of small and low-grade coal—Improvements by suitable preparation for market—Economy in use—By-product recovery—Economies possible from centralised systems of power generation: from extended use of carbonised coal, including gas—Low temperature carbonising schemes.

WILLIAM RIPPER, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. (unless otherwise announced):—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications." Two Lectures.

January 3, 10.

PROCEEDINGS OF THE SOCIETY.

THE SOCIETY was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom: and for meritorious works in the

various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country." In 1908 the Society was granted the privilege of adding "Royal" to its title.

Fellowship.—At the Annual General Meeting held on June 24th, 1914, a By-Law was made authorising all Members of the Society to use the designation of Fellow.

Ordinary Meetings.—Meetings are held every Wednesday during the Session (November to June), at which papers on subjects relating to inventions, improvements, discoveries, and other matters connected with Arts, Manufactures, and Commerce are read and discussed.

Indian Section.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

Colonial Section.—This Section was formed in 1874 under the title of the African Section. It was enlarged in 1879, to include the consideration of subjects connected with the Colonies and Dependencies. Four or more Meetings are held during the Session.

Cantor Lectures.—These Lectures originated in 1863, with a bequest by Dr. Cantor. The Lectures deal with the latest applications of Science and Art to practical purposes, and are, as far as possible, experimentally illustrated.

Fothergill Lectures.—Courses of Lectures, similar to the Cantor Lectures, are given from time to time under this bequest.

Howard Lectures.—The bequest of Mr. Thomas Howard (1872) is now devoted to occasional courses of Lectures on motive power and its applications.

Shaw Lectures.—Under the Shaw bequest Lectures on Industrial Hygiene are given from time to time.

Aldred Lecture.—The bequest of the late Dr. Aldred has been devoted to the establishment of an Annual Lecture.

Cobb Lectures.—Funds have been provided for occasional Lectures in memory of the late Mr. Francis Cobb.

Juvenile Lectures.—A Short Course of Lectures, suited for a Juvenile audience, is delivered to the children of Fellows during the Christmas holidays.

Admission to Meetings. — Fellows have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Fellow can admit two friends to the Ordinary and Sectional Meetings, and to the Cantor and other Lectures. Books of tickets for the purpose are supplied, but admission can also be obtained on the personal introduction of a Fellow. For the Juvenile Lectures special tickets are issued.

Journal of the Royal Society of Arts.—The *Journal*, which is sent free to Fellows, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

Examinations.—Examinations, founded in 1854, are held annually by the Society, through the agency of Local Committees, at various centres in the country. They are open to any person. The subjects include the principal elements of Commercial Education and Music. Full particulars of the Examinations can be had on application to the Secretary.

Library and Reading-room.—The Library and Reading-room are open to Fellows, who are also entitled to borrow books.

A History of the Society has lately been published (John Murray, pp. 558, 15*s.* net) and can be obtained from any bookseller. It gives a history of the Society's work from 1754 to 1880.

Conversazioni are held, to which Fellows are invited, each Fellow receiving a card for himself and a lady.

Election of Fellows.—Candidates are proposed by Three Fellows, one of whom, at least, must sign on personal knowledge; or are nominated by the Council.

The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day preceding election; or a Life Subscription of Twenty Guineas may be paid. There is no Entrance Fee.

CALENDAR FOR THE SESSION.

The following is the Calendar for the Session 1916–1917. It is issued subject to any necessary alterations:—

NOVEMBER, 1916

1	W	
2	Th	
3	F	
4	S	
5	S	
6	M	
7	Tu	
8	W	
9	Th	
10	F	
11	S	
12	S	
13	M	
14	Tu	
15	W	Opening Meeting
16	Th	
17	F	
18	S	
19	S	
20	M	
21	Tu	
22	W	Ordinary Meeting
23	Th	
24	F	
25	S	
26	S	
27	M	Howard Lecture I. 1
28	Tu	
29	W	Ordinary Meeting
30	Th	

DECEMBER, 1916

1	F	
2	S	
3	S	
4	M	Howard Lecture I. 2
5	Tu	
6	W	Ordinary Meeting
7	Th	
8	F	
9	S	
10	S	
11	M	Howard Lecture I. 3
12	Tu	
13	W	Ordinary Meeting
14	Th	Indian Section
15	F	
16	S	
17	S	
18	M	
19	Tu	
20	W	Ordinary Meeting
21	Th	
22	F	
23	S	
24	S	
25	M	CHRISTMAS DAY
26	Tu	*Bank Holiday*
27	W	
28	Th	
29	F	
30	S	
31	S	

JANUARY, 1917

1	M	
2	Tu	
3	W	Juvenile Lecture I.
4	Th	
5	F	
6	S	
7	S	
8	M	
9	Tu	
10	W	Juvenile Lecture II.
11	Th	
12	F	
13	S	
14	S	
15	M	
16	Tu	
17	W	Ordinary Meeting
18	Th	Indian Section
19	F	
20	S	
21	S	
22	M	
23	Tu	
24	W	Ordinary Meeting
25	Th	
26	F	
27	S	
28	S	
29	M	Cantor Lecture II. 1
30	Tu	Colonial Section
31	W	Ordinary Meeting

FEBRUARY, 1917

1	Th	
2	F	
3	S	
4	S	
5	M	Cantor Lecture II. 2
6	Tu	
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	S	
12	M	Cantor Lecture II. 3
13	Tu	
14	W	Ordinary Meeting
15	Th	Indian Section
16	F	
17	S	
18	S	
19	M	Cantor Lecture II. 4
20	Tu	
21	W	Ordinary Meeting
22	Th	
23	F	
24	S	
25	S	
26	M	
27	Tu	Colonial Section
28	W	Ordinary Meeting

MARCH, 1917

1	Th	
2	F	
3	S	
4	S	
5	M	
6	Tu	
7	W	Ordinary Meeting
8	Th	
9	F	
10	S	
11	S	
12	M	Cantor Lecture III. 1
13	Tu	
14	W	Ordinary Meeting
15	Th	Indian Section
16	F	
17	S	
18	S	
19	M	Cantor Lecture III. 2
20	Tu	
21	W	Ordinary Meeting
22	Th	
23	F	
24	S	
25	S	
26	M	Cantor Lecture III. 3
27	Tu	Colonial Section
28	W	Ordinary Meeting
29	Th	
30	F	
31	S	

APRIL, 1917

1	S	
2	M	
3	Tu	
4	W	
5	Th	
6	F	GOOD FRIDAY
7	S	
8	S	EASTER SUNDAY
9	M	*Bank Holiday*
10	Tu	
11	W	
12	Th	
13	F	
14	S	
15	S	
16	M	
17	Tu	
18	W	Ordinary Meeting
19	Th	Indian Section
20	F	
21	S	
22	S	[IV. 1
23	M	Howard Lecture
24	Tu	
25	W	Ordinary Meeting
26	Th	
27	F	
28	S	
29	S	[IV. 2
30	M	Howard Lecture

MAY, 1917

1	Tu	Colonial Section
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	S	[IV. 3
7	M	Howard Lecture
8	Tu	
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	S	
14	M	
15	Tu	
16	W	Ordinary Meeting
17	Th	Indian Section
18	F	
19	S	
20	S	
21	M	
22	Tu	
23	W	Ordinary Meeting
24	Th	
25	F	
26	S	
27	S	WHIT SUNDAY
28	M	*Bank Holiday*
29	Tu	
30	W	
31	Th	

JUNE, 1917

1	F	
2	S	
3	S	
4	M	
5	Tu	
6	W	
7	Th	
8	F	
9	S	
10	S	
11	M	
12	Tu	
13	W	
14	Th	
15	F	
16	S	
17	S	
18	M	
19	Tu	
20	W	
21	Th	
22	F	
23	S	
24	S	
25	M	
26	Tu	
27	W	Annual General Meeting
28	Th	
29	F	
30	S	

The Cantor and Howard Lectures and the Ordinary Meetings (unless otherwise announced) will commence at Half-past Four or Five o'clock.

The Meetings of the Indian Section and the Colonial Section will be held at Half-past Four o'clock.

The Annual General Meeting will be held at Four o'clock.

The Juvenile Lectures will be given at Three o'clock.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 15th, 1916; Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Barstow, Hon. George Eames, Barstow, Texas, U.S.A.
Brooker, Hon. Charles Frederick, A.M., The American Brass Company, Ansonia, Connecticut, U.S.A.
Cameron, Alexander, Government Dockyard, Massaruni, British Guiana.
Carver, George W., The Tuskegee Normal and Industrial Institute, Tuskegee, Alabama, U.S.A.
Clerk, Mrs. Dugald, Lukyns, Ewhurst, Surrey.
Cossar, Wilayat Hussain, The Watan, Lahore, India; and The University, Glasgow.
Currimbhoy, Hon. Sir Fazulbhoy, 13, Esplanade-road, Bombay, India.
Daubeney, Rev. A. R. Vaughan, East Walton Vicarage, King's Lynn.
Dhar, His Highness the Raja of, K.C.S.I., Dhar, India.
Eddy, Charles B., 62, Cedar-street, New York City, U.S.A.
Fenimore, Miss Beulah A., 147, Manheim-street, Philadelphia, Pennsylvania, U.S.A.
Garrett, Miss Mary S., Belmont and Monument Avenues, Philadelphia, Pennsylvania, U.S.A.
Glynes, Webster, Hamston House, Kensington-court-place, W.
Goodwin, William V'Alters Summers Gradwell, J.P., F.G.S., Red Heath, Silverdale, Staffordshire.
Greenwood, Thomas, 10, John-street, Hill-street, Mayfair, W.
Haidar, Haji Saiyid Jalaluddin, M.A., Aitchison Chiefs' College, Lahore, India.
Higgin, William Henry, B.Sc., The Elms, Parkstone, Dorset.
Holeman, Frederick Alfred, M.I.E.S., Jibutil Gold Mines, Morriston P.O., South India.
Horsfeld, H. E., Cuttack, Orissa, India.
Humphreys, J. Charlton, Junior Athenæum Club, 116, Piccadilly, S.W.
Hutton, J. Arthur, 15, Cross-street, Manchester.
Kershaw, Louis James, C.I.E., India Office, Whitehall, S.W.
Khan, Syed Ahmad Ali, Salimpur, Lucknow, India.
Lenygon, Henry, 31, Old Burlington-street, W.; and 16, East 60th Street, New York City, U.S.A.
Limaye, Professor Hari Govind, Fergusson College, Poona City, India.
Lockington, A. H., 1, Howard-road, Westbury, Bristol.
Mackenzie, James, Messrs. Macneill & Co., Calcutta, India.
Marston, Edwin S., 22, William-street, New York City, U.S.A.
Muir, Peter Gillespie, M.I.E.S., Calle Espartero 35, Ferrol, Spain.
Mukerjee, Haridas, Victoria Cottage, 14/3, Upper Circular-road, Calcutta, India.
Murdoch, Frederick Teed, British Consular Agent, Mansourah, Egypt; and Nile Lodge, Queen's Walk, Ealing, W.
Myers, Dudley B., Junior Carlton Club, Pall Mall, S.W.
Myers, Horace, The Sugar Wharf, 188, Harbour-street, Kingston, Jamaica, British West Indies.
Noel, Miss Emilia Frances, 37, Moscow-court, W.
Panday, H., B.A., Archæological Survey, Eastern Circle, Bankipur, India.
Pill, John R. G., M.Am.Soc.C.E., Corona, Alabama, U.S.A.
Rathbone, George, J.P., Ivy Lodge, Aigburth, Liverpool.
Roberts, William Henry, Hollin Royd, Victoria Drive, Eastbourne.
Scott, Henry, A.M.I.Mech.E., M.I.E.S., P.O. Box 42, Te Kuiti, New Zealand.
Shrosbree, Albert de Bois, F.S.I., 5, Clive-street, Calcutta, India.
Singh, Bhagat Lakshman, Government High School, Bhera, Shahpur District, Punjab, India.
Spencer, Professor Matthew Lyle, A.M., Ph.D., 8, Alton-court, Appleton, Wisconsin, U.S.A.
Surridge, William Alfred, 167, Auckland-road, Upper Norwood, S.E.
Tagore, Ranendra Mohun, Purana Baree, 6, Raghunundun-lane, Calcutta, India.
Tearoe, James, M.Inst.C.E., M.I.Mech.E., 409 and 410, Strand, W.C.
Thompson, Colonel Robert Means, Wall-street Exchange Building, 43, Exchange-place, New York City, U.S.A.
Timson, Rowland Clunbury, "And," Greenway, Berkhamsted, Herts.
Watson, Charles Cuningham, C.I.E., Commissioner's House, Ajmer, India.
Whymark, George Harvey, 7, Kyo-Machi, Kobo, Japan.
Wills, Miss Elizabeth, 10, Rock-street, Fall River, Massachusetts, U.S.A.

The Chairman delivered the following

ADDRESS.

Again I have the honour of addressing you as Chairman of Council of the Royal Society of Arts, at the beginning of our one hundred and sixty-third year of active life. Last year I chose for my subject the past achievements of England, and contrasted them with those of Germany. Now I propose to discuss broadly some conditions of the stability of Great Britain and the Empire; and further, to consider some of the changes which are desirable in order to increase our security and prosperity.

Stability in the static sense has no existence

in this world of change, but there is a real dynamic stability such as is seen in the long-continued motion of the bodies comprising a solar system. It is true that any one solar system must have an end, although millions of years elapse; but ultimately the continued existence of a universe of suns and worlds depends not upon the continuance of the units, but upon the infinity of space and star systems. The stability of the world, as we see it, is due to the running down of a stream of energy, and life exists only in the process of flow of energy throughout a system; life ceases to be possible when the flow ceases.

The stability of the British Empire is dynamic; it is a stability of living form maintained alive by incessant change. Our stability is maintained by the perpetual adjustment of our lives to new conditions as they arise, and from the continuous struggle of individual interests there emerge certain interests recognised to be common to the whole body. The first common interest is freedom: freedom to order one's life at one's pleasure, to follow any course thought to produce a sufficient livelihood, and then to cultivate our interest in science, art, literature or sport—whatever we conceive to be necessary for our happiness—without Governmental hindrance; liberty limited only where it would inconvenience our neighbours.

So it happens that within the Empire many diverse courses are energetically pursued by individuals and by our great Dominions, Colonies and Protectorates over the seas. The ideal of Australia is different from that of Canada: New Zealand differs from both, and also from Great Britain and Ireland. The visit of Mr. Hughes showed most clearly the different view-point of the Dominions. Mr. Hughes' ideal differed so much from the British ideal that at times his utterances seemed unintelligible. The key to his attitude and that of the Dominions is found in a recent Address to the Victorian Chamber of Manufactures, delivered by its President, Mr. Herbert Brooks, who stated: "The objective of a self-contained Commonwealth within a self-contained Empire has been with this Chamber from the beginning." That is not the ideal of Great Britain; for nearly three centuries she has attempted to utilise the resources of the whole world. The idea of a self-contained country is possible, and even plausible, in a great continent like Australia, where the area and climate suffice to produce almost everything necessary for comfortable life. It is even possible for Canada, and still more plausible for the country of our great cousins, the United States.

The small area and the isolation of Great Britain and Ireland from the rest of the world by the sea prevented this from becoming the ideal of Great Britain. When Britain led the world about the middle of the eighteenth century from the agricultural to the industrial stage of civilisation, it was rapidly borne in upon her that the growing population could not comfortably subsist on the agriculture of these islands. It was obvious from the straits of the "hungry forties" that it was by no means easy to provide food for even the 24 millions then forming the population; much less was it possible so to provide for the wants of the 46 millions, our present population. Some say that by improved agriculture we should be able to support our population in comfort without external food supplies; and they point to the example of Germany, which, before the war, by intensive cultivation and lavish use of imported nitrates and other fertilisers, had succeeded in greatly increasing her agricultural yield. The argument for a self-contained country from the food point of view is supported by the logic of facts in time of war. Obviously during war a sufficient supply of food from our own soil would be a great advantage; one great danger would be abolished. Germany and Austria-Hungary between them have an area of about 450,000 square miles, and undoubtedly they could in time of peace produce food sufficient to support their population of about 116 millions on a low scale of comfort. The Central Empires have now an admirable opportunity of realising the ideal of the Australian, that of a self-contained Empire. The British Fleet is obliging them to this extent, and is protecting them from commercial attack by the external world. Germans and Austrians should be very happy in the realisation of this self-contained ideal, but apparently their condition is one which they desire to terminate as soon as possible. Their experience of two years has taught them that in times of war it is just possible to exist on the agriculture of their extensive lands, but only in a state of great discomfort and low vitality.

The mean density of the population of the United Kingdom is about 50 per cent. greater than that of the Central Empires, so that what is just possible for them is impossible for us, and accordingly we were forced by facts staring us in the face to embark upon schemes of expansion which would enable us to obtain food and other matters necessary for comfort and luxury

from every part of the world. To purchase these external products from the over-seas portion of our Empire and the other nations it was necessary that we should produce goods and perform services which the world required. This we did in the most successful manner. We manufactured and exported goods to every part of the world; we produced a great fleet to carry our goods and to return with all the products of the earth, and we performed services of the most important kind to the world at large, which have resulted in increasing the productions of the world required by man in every country and clime. From 1750 to the present day Great Britain has led in science, invention, manufactures and finance. From 1830 till 1913 (eighty-three years) Great Britain has steadily increased in the wealth and comfort of its people. This is easily shown by examination of the exports of British produce; the increase of national capital, of total national income, and of population, and income per head. The exports of British goods were, in 1805, 38 million pounds in value; between 1805 and 1830 the value rose to 48 millions, but fell to 38 millions again in 1830. The condition of the people in these early twenty-five years was stationary, but it steadily improved from 1830 to 1913, when the exports rose to 525 millions. This is clearly shown by the following table:—

EXPORTS OF BRITISH GOODS FROM 1805 TO 1913.

Year.	Exports. £	Year.	Exports. £
1805	38,000,000	1880	223,000,000
1830	38,000,000	1890	263,000,000
1840	51,000,000	1900	291,000,000
1850	71,000,000	1910	430,000,000
1860	136,000,000	1913	525,000,000
1870	199,000,000		

The rise in the value of British exports is steady and considerable, and even in the latest period of twenty-three years the increase was from 263 to 525 millions—almost exactly double. This proves increase in trade, but it does not follow that prosperity also increases. The object of agriculture, manufactures and trade is efficiently to feed, clothe and house our people, and the measure of efficiency is expressed in the sum of wealth and the income attained by work of every kind considered in connection with the total population at each period. The earliest attempt to measure the capital wealth of England was made by a British merchant in the year 1600; he estimated it at a total of 100 millions sterling; with a population of 4½ millions this gives £20 per head.

No broadly founded values were obtained till 1865. Capital, population, and capital value per head have increased steadily since that date. This is shown by the table below:—

INCREASE OF TOTAL WEALTH OF THE UNITED KINGDOM FROM 1865 TO 1914.

Year.	Total Capital, United Kingdom.	Population.	Capital per Head.
	£	Millions.	£
1865	6,113,000,000	29·9	204
1885	10,037,000,000	36·0	287
1905	13,036,000,000	42·8	304
1909	13,986,000,000	44·4	315
1914	16,000,000,000	46·0	347

The total capital of the United Kingdom has thus increased from 6,113 millions in 1865 to 16,000 millions in 1914, while the population increased from nearly 30 to 46 millions. Had the total capital value been uniformly divided among the population, each man, woman and child would have possessed property to the value of £204 in 1865 and £347 in 1914. Capital value is difficult to determine with accuracy, because it includes not only material things, such as land, cattle, grain, ships, railways, houses, furniture and clothing, but also immaterial things, such as goodwill of different trades and professions. Total income can be estimated with greater accuracy.

INCOME.

Population and income per year per head have increased steadily since 1867, as shown by the following table:—

INCREASE OF TOTAL INCOME OF THE UNITED KINGDOM FROM 1867 TO 1915.

Year.	Total Income, United Kingdom.	Population.	Income per Year per Head.
	£	Millions.	£
1867	814,000,000	30·5	26·7
1875	1,200,000,000	32·8	36·6
1885	1,350,000,000	36·0	41·3
1907	2,000,000,000	43·6	45·8
1915	2,500,000,000	46·0	54·3

The income of the country has thus increased from 814 millions in the year 1867 to 2,500 millions in the year 1915; and the income per head of the population from under £27 per head to over £54 per head.

The income of the whole British Empire was given as follows by Mr. Edgar Cramond, F.S.S., in a lecture delivered on December 3rd, 1915:—

BRITISH EMPIRE INCOME FOR 1915.

	£
United Kingdom	2,500,000,000
Canada	350,000,000
Australia	230,000,000
South Africa	50,000,000
New Zealand	55,000,000
India	700,000,000
Crown Colonies and Protectorates	150,000,000
	£4,035,000,000

From this it appears that the annual income of the whole British Empire amounts to the enormous total of 4,000 millions, of which the United Kingdom produces 62 per cent., while all the other populations produce 38 per cent. When we consider that the population of the Empire in 1914 was about 400 millions, and that of the United Kingdom only 46 millions, it is most evident that our population, taken as a whole, is industrious and successful.

With regard to Germany, wealth and income have also increased. For the year 1895, Schmoller estimates the income per head of the whole population as £23; but Helfferich arrives at a lower value—£20·5 for the same year; and for the year 1912 Helfferich states the income as £30 per head. For the later year 1914, German Government figures, disseminated by wireless messages, state £32 per head as the value. Taking their own valuations, therefore, for the year 1914, the German income per head amounts to only 60 per cent. of that of the United Kingdom. The state of the German population as to efficiency in 1914 has only reached the stage attained by our population about the year 1874. From this it is evident that Germany must improve greatly in general efficiency before she can even pretend to equal Great Britain.

It has been said that Germany by her competition has diminished our foreign trade; this has been proved to be incorrect by Mr. R. H. O'Farrell in an article "British and German Export Trade before the War" (the "Economic Journal," June 1916. See Appendix).

It is to be remembered that in 1914 the population of Germany was roundly 68 millions, while that of the United Kingdom was 46 millions; so that the total income of the Germans was about 200 millions short of ours. The income per head being so much higher with us, we are in a better position to provide for war; thus our annual savings just before the war amounted to 350 millions, while in 1915 they increased to 600 millions. That large sum can be increased by further limitations in private expenditures, and it may even reach 1,000 millions in the present year (1916). This increase, with the savings possible in both Army and Navy, will relieve us from undue anxiety as to provision of funds for an even longer war than seems in the least degree probable.

Germany's external investments before the war amounted to about 1,000 millions, while ours were 4,000 millions, of which only a small part was placed in Europe and Asia. Germany, by the power of Great Britain's Fleet, is deprived of all access to her foreign investments during war, while we are free to utilise nearly all our foreign securities by calling upon America, our Dominions, Colonies and Protectorates for the supplies required. Further, the Navy has annihilated Germany's foreign trade, on which she depended for a large part of her income; so that while our available income increases, Germany's surely diminishes as the war proceeds. In power of procuring the material things and services required for war, we are in a position of great and undoubted advantage. All the nations of the world were indebted to us; we were the great creditor nation, and our capital placed abroad, which Sir George Paish estimated at 4,000 millions, now stands us in good stead, and together with our other measures places us in a position of secure stability. Of this large sum, Canada and Newfoundland owe 515 millions; Australia, 332 millions; New Zealand, 84 millions; and the United States of America, 754 millions. This capital was necessarily supplied by us to stimulate the growth of food and the production of other materials necessary to our existence. Sir George Paish has well summed up the position as follows: "It is sometimes assumed that the regularity with which we obtain our supplies of food and raw material is merely a matter of destiny, as everything else is; but you will realise that the common-sense of the British people has assisted destiny in providing the capital needed to bring to the shores of Great Britain the fruits of the earth in their due season, and in regular weekly and monthly shipments the endless

wealth that has lain beneath the surface of the earth in countless ages.

"In brief, the economic and financial strength of this country is founded upon the welfare, not merely of the British people, but practically all countries, and it has been built up not by any local or narrow policy, but upon the broadest possible lines."

Had Great Britain followed the Australian and Canadian ideal, neither of the Dominions would have received the assistance of this country's capital. Britain, too, was so broad-minded as to put no restrictions whatever upon the Dominions because of the capital received. For example, the 36 millions a year going to Canada, it appears, was mostly used by the Canadian people for the purpose of buying goods from the United States, and that country in turn used the money so placed to its credit in London for the purchase of tea from India, silk from Japan, coffee from Brazil, French works of art, etc. Ultimately, however, our credit to Canada is settled by exports to those countries where British goods are needed.

No, the Colonies are wrong in the idea of a self-contained Commonwealth, and Britain is right in her idea of expansion in trade over every part of the world. It is a necessity of our position; without it there can be no stability. The Colonial idea arises from a false notion of what trade is. It will often be observed in the case of the Dominions, and certainly in the case of Australia, that a self-contained colony is not a colony in their meaning in which all efforts are devoted to obtaining the products required for comfortable life from their own soil, but one in which wealth is attained by manufactures and agriculture, from sales made to other nations, and evidently no purchases by them are expected to balance the sales. Indeed, from some statements frequently made, the idea is that an exporter of goods from Australia is patriotic, while an importer is unpatriotic and seeks his own interest regardless of the good of the community. The idea that money is the real or ultimate payment for goods and services seems strongly held by the Colonial mind. England has long ago realised that all goods and services are ultimately paid for in goods. It is not difficult to follow the somewhat infantile reasoning of those who fail to understand the nature of payment between nation and nation. Every manufacturer feels the difficulty of selling. He organises an extensive mechanism of sale, advertisement, travellers, show-rooms for his goods, in many cities in all parts of the world. He sees his goods leave the works and travel all over the world, and the only returns of which he is conscious are the cheques in payment of the goods he sends. He often forgets that money is only a foot-rule for measuring goods and services. It is true that the metals, gold and silver, have an intrinsic value, as wealth, apart from their use as means of measurement; but only a small share of the transactions of the world are accomplished by actual gold and silver payments; the real money payments are by drafts and cheques, which only serve as certificates that certain goods and services have come into existence and are to be balanced against other goods and services. What a nation requires is not money, but material things and services. All that the financial system does is to make possible the exchange of these goods and services within the country and in the external world. Many fail to realise the essential truth that goods and services are only paid for ultimately in goods and services; and further, that the difference between nation and nation is always settled by the import of goods into the creditor country. All real payments, in fact, are in goods and services. Many seem to imagine that the world consists in a series of competing nations, each clamouring to sell but none desiring to buy. War is provoked, according to this notion, by the struggle for markets. It seems to be entirely forgotten that the goods bought in the world are the same as the goods sold; that is, that imports and exports are different names for the same goods. The imports into the nations of the world, so far as the goods are concerned, must be equal to the exports, because they are the same things, called exports at the country of origin and imports at the country of arrival. The analogy of war as applied to commerce is entirely false. Commerce is not a war. Some carry the analogy so far as to imagine a prosperous Great Britain in a poverty-stricken world. People of that type would attempt to render Britain wealthy by making the world poor. They look upon the increase of wealth of the United States with fear and jealousy, and entirely without reason. It will be found, on the most careless examination, that wealth increases simultaneously in industrious nations—a wealthy America means a wealthy England. We must not even forget that a poverty-stricken Germany and Austria would re-act upon the whole world. Punish the Germans and Austrians by all means—they thoroughly deserve it—but do not imagine that by cutting those nations out of

the world's commerce the other nations can be rendered more wealthy. The very opposite is the real effect; in so far as Germany and Austria are poor the rest of the world will share in their poverty. Punishment of these nations should therefore be military, not economic in the sense of rendering production and output difficult. Their war indemnity payments to the Entente Powers must be sufficiently large to reinstate Belgium, France, Serbia, and Russia, and for every ship sunk of the Allies and neutrals a ship must be exacted. Such payments can only be made in material things, and will absorb a very large part of any income which Germany and Austria can make for many years to come. All their powers of production will be required to restore the material damage they have wickedly done.

Notwithstanding the diverse ideals existing within the British Empire, freedom and tolerance allow even antagonistic systems to harmonise. Goodwill between the Mother Country and the Colonies, based upon the belief that Mother Country and Colonies are unselfishly attempting to work out, not only their own salvation, but the salvation of the Empire, permits each to work in its own way, and even in the diversity of method there is a safety to the Empire. Great Britain has by long experience found a mechanism and a method of maintaining her population in considerable comfort. In interesting herself in science, art, literature, and all the things which make life worth living and human mental progress possible, Britain thus contributes her share to the well-being of the Empire first, and second, of the world. The Colonies work out their problems; they learn, find some things possible, others impossible. Any attempt to impose a theory of life or government from the Mother Country would only end in disruption. The experience of America shows us that. This great war, however, sad as it is in loss of splendid lives, is a gain to the Empire. The Kaiser, in his foolishly short-sighted German way, thought to break down the Empire, felt indeed, as one of his professors said, that the giant idol of Britain with feet of clay only required a vigorous push to bring it to the ground. His attempt has had precisely the opposite effect. The struggle with Germany and Austria is a unifying influence, giving every man and woman in the British Empire something to do for a cause deemed just by all. The Empire will be stronger after the war than before. We in Britain shall listen to Mr. Hughes and our Colonial friends who sometimes lecture us upon our misdeeds, with little belief perhaps in those misdeeds, but with an affectionate interest in the speakers, who have no doubt the good of the Empire at heart, and who have shown by their conduct that they stand for an Empire of Truth, Honesty, and Justice. The very liberty and apparent looseness of the bond throughout the British Empire is one of its greatest points of strength. In time each constituent of our great Dominions will work out for itself, in conjunction with the Mother Country, a system best suited to its needs. Each system will gradually be perfected by trial and error, and ultimately the Colonials will recognise that the Mother Country has acted for their good, for Britain's good, and for the good of the world, even when they, from their more restricted view, thought that Britain was following an erroneous ideal.

But the Colonials are by no means alone in calling for drastic change in our methods. Even scientific men consider us to trust too much to haphazard means. The signatories to the Neglect of Science Manifesto, published at the beginning of this year, make the following general statement: "Our success now, and in the difficult time of reorganisation after the war, depends largely on the possession by our leaders and administrators of scientific method and the scientific habit of mind. They must have knowledge and the habit of promptly applying known means to known ends. To trust to luck is a mark of the dangerous complacency bred of ignorance. The evidence of those back from the Front makes it clear that, as of old, our 'people are destroyed for lack of knowledge.'" No doubt people are destroyed for lack of knowledge; but, alas! no man or body of men can give us the knowledge to enable us promptly to apply the known means to known ends, not even the best of scientific men. Except in very simple matters, in order to apply known means to known ends it is necessary to experiment and make numerous trials. The whole work of the scientific man is based upon experiment; even in mechanical matters it is impossible to predict at long range—no new machines or even improvements in machines have been produced by the most intelligent and scientific men without long experimental trials, much less is it possible to predict with certainty the course to be taken in so complicated circumstances as the conflicting interests of a nation.

I agree with my brother scientific men in wishing to secure a more general appreciation of science and scientific men. Certainly science

should be valued more highly in our colleges and schools. But Great Britain has always been rich in scientific discoveries and men of the first rank, and knowledge is rapidly spreading. We have many highly-trained scientific men at present engaged in the application of science to industry. Their success is much greater than many appreciate.

In national affairs there are two ideals of action—one, the rigid logical working out of what are believed to be all possible contingencies and providing for them far in advance. This is the method attempted in Germany. But it requires a being at the head of affairs who is not only all wise but all good and powerful, as the Kaiser supposes himself to be. Had he been so, there would have been no war. The war was due to his and his nation's greed and wickedness, and the systematic obedience of Germany has only made it easier for the mistaken and wicked few at the head of affairs to lead the whole nation downwards to destruction. The British do not believe in the existence of the all-wise or all-good person—the strong man to whom everything is known; they are acutely conscious of the imperfections of human nature, and they are not willing to trust their whole fate to the rulers of the State. On the contrary, they believe with Sir George Paish that "a really clever nation or a really clever man becomes not infrequently a public danger." Sir George's estimate, given as follows, seems to me in the main true: "The British nation has never made the mistake of being too clever. The greatest qualities possessed by the British nation are common-sense and courage combined with lack of imagination. Their foresight is confined to doing the next thing that presents itself. Each difficulty as it arises is dealt with either wisely or unwisely. Their great wealth has been built up by their inability to realise the meaning of the word 'danger,' either from a physical or from a financial standpoint. The British people are prepared to take greater risks than any other people in the world, and this quality has brought to them an income and a degree of well-being that can scarcely be measured."

By thus dealing with each difficulty as it arises, on the whole a better adjustment to the circumstances is obtained than can be effected by the most careful prevision. No doubt mistakes are made, but they are usually mistakes capable of ready rectification. Great Britain thus depends upon the struggles of the democracy. Such struggles may give evidence of much ignorance and error, but the acts which emerge are those which are possible, and are by no means the result of the trusting to luck referred to. Either we must be all wise and good if we are to trust to a scheme carefully planned in advance, or we must trust to the nature of the mass of human beings who form the nation. If that mass be good, capable and honest, then the result in the main will be good. Mr. Asquith and the Coalition Government acted promptly enough when the nature of the circumstances to be faced became visible, but till vision cleared the way they very prudently and rightly practised the "wait and see" attitude which the purely scientific man considers so erroneous.

Contrasting the disasters which have befallen German logical preparation with our rapid growth of strength and power, which is the result of the apparently irregular British method, it must now be evident to all the world that British stability stands firm while German thought has resulted in instability and disaster. I do not for one moment say that the British method is perfect; it can undoubtedly be improved upon, but before any improvement can be attempted it is necessary to admit that on the whole Great Britain has been highly successful. Changes are no doubt necessary, but they are not changes of the order imagined by those who say, like Mr. Hughes, "Never again shall we be caught in the position of the autumn of 1914." Looked at sanely it will be acknowledged that at no time in Britain's history had she been more prepared for the task which she undertook than in August, 1914—the Fleet was ready; the Expeditionary Force was ready. The difficulties, as I pointed out last year, were not on the side of Britain, but on that of our gallant Allies. Since last I had the honour of addressing you a year ago, Britain has made enormous progress in the production of munitions for war, in the development of the aeroplane, improvements in its structure and in its engines, in the design of special means of attack, such as the "Tanks," and numerous other matters, and in the great strengthening of the Fleet and the Army.

The Fleet is overwhelmingly the strongest in the world, and the Army now ranks among the most powerful and well-equipped in the field. The war can now have but one end: the complete collapse of the Central Powers and their allies—Turkey and Bulgaria—and the victory of the Entente Powers—Britain and the Empire, France, Russia, Belgium, Serbia, Rumania, and Japan.

At the termination of this war the British Empire will occupy a position which it has experienced before at the end of a great war, much more powerful in Navy and Army than at the beginning, while her enemies will be weak and at the end of their resources.

What changes then are desirable after war?

There are some points on which all agree. It is necessary to raise the standard of living of the working-classes, although the average income is higher than that of any other European country; yet much more must be done to abolish the poverty which is still too common among the unskilled workers; undoubtedly wages must be raised. How is that to be done? The Socialists used to say that modern machinery and science had increased production to such an extent that the whole error of society lay in the division of the products of industry and not in the actual lack of produce. The capitalistic system of society, they said, enabled the employers to exploit the employed, so that the capitalist reaped the great harvest, leaving only a few poor ears of corn to be gleaned by the workers. The first Census of Production of Great Britain (1907) is an invaluable contribution to our knowledge of the true facts. Broadly, the results are these:—

The total income of the country in 1907 is estimated at 2,000 millions; this is made up of payments for both material things or goods and service of all kinds.

The net output of the scheduled industries of the country is 712 millions; this sum is determined from the goods sold by all the industries at the works prices before any additional expense is incurred by carriage, storage, etc., by deducting from the total output of all the works, the payments made for materials and partly manufactured goods entering the works. The sum, 712 millions, is thus the whole product of the labour of the hands employed rendered possible by the provision of works, machinery, materials from outside, and the invention and design of engineers and men of science. The sum is the source of all payments for labour and capital; and as the total number of workers employed is 6·98 millions, the total earnings of industry per head per annum is £102. If, then, every worker in each factory, masculine and feminine, were paid at the rate of two pounds per week, the whole sum would be exhausted without providing remuneration for capital or a fund for extension of works and development of new inventions or industries.

The value of the agricultural output of the country is 210 millions, and that of fisheries about 12 millions.

The number of people engaged in agriculture is 2,324,000 and in fisheries 107,500; so that the total of those occupied in direct production of goods and food, including employers and salaried persons, is—

Manufactures	8,250,000
Agriculture	2,324,000
Fisheries	107,500
	10,681,500

—that is, 10·681 millions, over 10½ millions.

The total value of the work of those 10½ million people was—

	£
Manufactures	712,000,000
Outwork not scheduled	50,000,000
Agriculture	210,000,000
Fisheries	12,000,000
	£984,000,000

—so that of the whole income of the country of 2,000 millions, under one-half was due to direct production.

Over 1,000 millions in the aggregate was earned by those engaged in transport, distribution, banking, insurance, foreign and Colonial investments, professional services, such as law, medicine, trading, engineering design for abroad, and domestic and personal service. The services for abroad on balance were paid for by 128 millions (the excess of imports over exports in 1907) worth of imported goods and reinvestment in foreign securities, which did not in that year result in sending goods to this country.

The total goods retained for home consumption was thus valued at about 1,100 millions—

	£
Manufactures, agriculture and fisheries, price at works or place of production	984,000,000
Excess of imported goods over exports, price at port of entry into country	128,000,000
	£1,112,000,000

The expenses and profits of transport and distribution, railways, motor and horse traction, water carriage, warehouses, shops, etc., before reaching the consumer amount to about 500 millions, so that the consumer pays for the goods altogether about 1,600 millions. This represents the material remuneration of all producing and distributing and transport and professional and personal services.

The remaining income of 400 millions is that

accruing for services. The total income of 1907 is thus made up broadly—

	£
Material things at place of origin or port of arrival	1,100,000,000
Distribution and transport of those things	500,000,000
Professional and personal services .	400,000,000
Total income of 1907 . .	£2,000,000,000

In 1907 the population of the United Kingdom was 43·7 millions, so that the income per head was £45·8.

The total production of the trades of the country as sold at the works was 762 millions, and if all be divided uniformly, $\frac{762 \text{ millions}}{8{\cdot}25 \text{ millions}}$ = £92·5 per individual engaged in production.

For agriculture and fisheries the total production was 222 millions; similarly divided, $\frac{222 \text{ millions}}{2{\cdot}43 \text{ millions}}$ = £91·4 per individual engaged.

The total net output per head in agriculture thus differs but little from that of the trades.

Out of a population of 43·7 millions, those aged between fifteen years and sixty-five, number about 27·7 millions, of whom 13·3 millions are male and 14·4 millions female. In 1907 we may assume 25 millions to be the reservoir from which we could obtain those actually engaged in the different kinds of work, manufacture, agriculture, fisheries, and services of different kinds. Of those about 11 millions are engaged in manufactures, agriculture, and fisheries, and the remaining 14 millions are occupied in distribution, transport, and professional work. The sum falling to this latter class is about 1,016 millions.

From this examination it will be seen that even if the whole products of the work of all classes be uniformly divided among the individuals, yet it is not possible to increase the remuneration sufficiently per head, because the material things produced are insufficient in quantity. To increase the real income of the country it is absolutely necessary to increase the production of every person. It is useless for scientific men to discover, and engineers to invent, new means and mechanism for producing from the earth the things we require for comfort unless the workmen be willing to use these means and machines to the best advantage. The best thing we can do at present for the future prosperity of the country is to convince the workman that it is in his interest to increase production to the utmost consistent with healthy life, and to show him that, in so doing, he increases the supply of materials available for the purposes of necessity and comfort which are brought into existence to be divided among the whole population.

Unfortunately many workmen and some trade unions conceive it to be their interest to restrict production, partly from the idea of keeping up prices by relative scarcity, and partly from a very kindly feeling that if any man does too much work he is robbing his neighbour workman of a job. He thinks that there are only a certain number of jobs to go round, and he does not wish to be selfish and throw other men out of employment. That is a completely erroneous view; it is in the interest of every workman in the kingdom to increase his production to the utmost. Many employers have, however, helped to confirm the workman in his error by a too narrow view of the limits of men's wages. After a fair piecework price has been settled, they do not allow the man to increase his earnings sufficiently by thought and industry. If his piecework earnings rise, say, to £5 per week, they consider the rate too high and seek to reduce it so that his wage shall be kept not higher, perhaps, than £3. This is an unjust and incorrect policy; workmen should not be so limited, or they will consider it to their interest to limit their production. Every inducement should be given to the workman to earn the largest sums, provided the price of each article is a fair one which can be borne by the selling price available. Both workmen and masters should alter their ideal in this respect. Trade unions have done excellent work for Great Britain in raising the standard of life of the workman, and we all sympathise with them in this. The higher the average standard of life in the country the better is both the internal and external trade of the country; but the trade unions should devote themselves to raise income by facilitating production and seeing to it that the workman is paid at proper piecework rates.

It is a remarkable fact that the United States of America, with its 100 millions of population, is adequately served as to its industrial needs by 8·85 millions of workers, while we require 8·24 millions to supply the needs of 43·7 millions. The American net output per head is about £220 for manufactures and £206 for mining. The net agricultural output is enormous; it is 1,100 millions for crops alone without live-stock. It is true that prices are higher in the United States of America than here, and so the output is magnified by the less goods obtained for a given sum; the prices, however, are believed

to average about one and a half times those in this country, so that if we divide £220 by 1·5 we get near £147 per head as the true equivalent of the £102 per head of the British Census.

It is to be noted, however, that the net output of the German workman is much lower than that of the British. We shall be nearly accurate if we say that the American worker in industry turns out one and a half times the real value of the British workman. This he is enabled to do by the difference in ideals of labour between the trade unions of the two nations. The American unions recognise that a large output is necessary, and they devote their energies to maintaining the high wages of the worker by keeping up the piecework prices, and accordingly we find that the total wages paid in American manufacturing amounted in 1909 to £687,000,000, or over £100* per annum per head; the wages formed 40 per cent. of the net output—and so, notwithstanding the dearer living, the people are on the whole better paid than here. It is not possible to say that they are really better off, as their hours are longer—sixty hours per week, no Saturday half holiday; while in Great Britain fifty-four hours form the standard week, and the Saturday half holiday is almost universal. An increase of the output of British manufactures to the extent of 50 per cent. by greater utilisation of automatic machinery would produce a very great improvement of our prosperity as a whole without increasing the working hours; but more especially it would act to raise the level of living of our wage-earning classes. The home trade would thus be greatly strengthened, and with it the foreign trade would improve also. There can be no effective demand for goods from a poor population, and wealth consists fundamentally in the total material production. Services are only of national value in so far as they are instrumental in producing and distributing actual things such as food, clothing, housing, and some services are necessary in order to keep us in bodily health and to maintain society in an orderly state in which all of us may enjoy the results of our labour. The improvement in the output of existing labour is therefore of vital importance. This, however, can be aided by opening numerous fields of activity to women. Women have shown themselves most capable and eagerly patriotic in the years of the war; they have had a chance to show what they can do, and they have abundantly demonstrated their skill and adaptability to new and strenuous conditions. Their skill, goodness and bravery is beyond all praise.

The future prosperous Britain will certainly arrange to utilise to the utmost women's work in many industries, both manufacturing and distributive; such a fund of energy and ability cannot fail to improve the income of the country. The workman need not fear competition; there is ample work for women, both in the trades and in the professions. Women will also be given their rightful position as fellow councillors with men in determining the course and affairs of the nation.

Our first aim at home, then, should be to increase the total of our material goods by improving the ideal both of labour and capital, and by encouraging women to take part in industry and the professions. Give women a fair field in outdoor life as well as in the life of the home.

Our next aim should be to impress upon the Dominions overseas the one great necessity for their healthy existence—a larger population. The late Professor Seely, in his "Expansion of England," predicted a combined British and Colonial population of 100 millions of Anglo-Saxon race for the year 1930. So far the Mother Country has succeeded, and the population of these islands is over 46 millions. That of the overseas Dominions, including Crown Colonies and Protectorates, is only 16 millions. Here we cannot expect to support in real comfort more than 50 millions of people, but with the huge area of Canada, Australia and New Zealand, they should between them easily maintain 50 million in a high degree of comfort and leave plenty of room for expansion. We should then have a British Empire with 100 million souls mainly of our own race—English, Scottish and Irish. Such a population would increase, not diminish, the wealth of every individual, and would greatly

* Notwithstanding the larger average income of the American workman, there seem to be conditions which give rise to much discontent. This is frankly expressed in an article in the *Engineering Magazine*, of September, 1915, by Mr. David Moffat Myers, M.A.S.M.E., a well-known American engineer. His statement is—

"In our factories all over those freedom-loving States of ours, there are thousands on thousands of human slaves—white slaves. 'The factory runs the town.' You know it as well as I do. You know these slaves. You are sorry for them, with their long, hard hours, their insufficient pay, their absolute lack of freedom. And these people, these human beings, constitute ninety per cent. of the people connected with your factory which pays dividends to the ten per cent. But what of the ninety? Has the factory improved their lives? Has it given them luxury, freedom, cultivation, and happiness? Has it improved their citizenship? No need to answer these questions. Everybody knows—when he stops to think.

increase the strength and importance of our overseas Dominions.

The present small populations of the Dominions is detrimental to their industrial prosperity; for example, the populations and income in 1914 stood as follows :—

	Population.	Total Income.	Income per Head.
		£	£
Canada	8,075,000	350,000,000	43·3
Australia	4,922,000	230,000,000	46·7

They have not yet attained to the £52 per head of the United Kingdom. They should in time equal, and even exceed, the wealth of the home country, because of their large area and wealth in coal, minerals and grain in Canada, and in minerals and cattle in Australia. To do this they must of themselves discover that the ideal of a "self-contained Commonwealth within a self-contained Empire" can lead them no further, and that it accounts for the relatively small progress they have made in power and importance compared to that of the United Kingdom. The world, after all, is but a small unit, and Colonial ideas as to industry and trade should expand in a more ambitious way so as to utilise the advantages of the whole range of products and services which our little sphere affords. Vigorous and able people such as the Canadians, Australians and New Zealanders should content themselves with no ideal of activity less than worldwide. I do not refer to warlike activity, but to the ordinary desires of mankind to live a life worth living in a peaceful way, so arranging that each individual's work benefits him or her and aims to benefit the world as well.

So far I have discussed things material rather than those intellectual, because Science, Art, Literature, and all other abstract matters require a country which is on the whole prosperous; the intellect cannot flourish in a poverty-stricken nation. All intellectual matters are of the utmost importance to the race; the highest interest of man is found in the development of the intellect; it is there that the consciousness of man differentiates him from the animals. Accordingly Great Britain would do well to improve the education of her people in order to give them a happier and more worthy life. Our knowledge of objective things is, after all, purely subjective, and our belief in the existence of objects external to ourselves gives a vivid interest to the pursuit of knowledge of the real things which we feel exist behind the veil of subjective sensations and impressions. The knowledge called scientific is, after all, but knowledge of the sequences of occurrences as observed through our senses and imagined by our consciousness. We observe many complicated happenings, and we classify them, referring them to divisions which we have created to enable our thinking powers to grasp something tangible; accordingly we divide Science into Biological and Physical. In each division we arrange apparently differing phenomena in one class, because of a common property, and we determine the quantitative laws of the various relationships. Such work gives us the highest pleasure, as an attempt to learn something of our wonderful world, and in this men who devote their lives to the most abstract of natural studies do noble service to all mankind, because they aid the development of human brain-power, so that in the distant future we may be able to achieve a real understanding of the simplest of things around us—a stage which we have not yet reached. The work of Science, Art, and Literature is all of a high order, and Science to its votaries is satisfying in itself as an ultimate aim; the scientific discoverer pursues his inquiry into the phenomena of matter and life with knowledge as an end in itself.

The increase of such abstract knowledge is necessary to Great Britain's stability; and, judging from the past and present, we shall never lack men who devote their lives to the pursuit of knowledge, so satisfying in itself and so vital to the continued conquest of Nature by man.

It is necessary, however, that we should as a nation recognise more fully the importance of co-operation and co-ordination in both abstract and applied science. We are intense individualists, and our great success in the world is largely due to that quality; it has, however, its drawbacks, and we have arrived at a stage of development in both science and industry where united effort would aid us rapidly to improve our scientific and industrial position. I accordingly welcome the movement of Co-ordination of Scientific Societies originated by the Royal Society and the establishment of the Privy Council Committee for Industrial and Scientific Research by the Government. Great technical and industrial progress will result from the joint action of those bodies with groups of the great industries on which our comfort and security depend.

The joint work of the Advisory Committee for Aeronautics, the National Physical Laboratory, and the Royal Aircraft Factory for years past is proved to be eminently successful by the dominant position of our aeroplanes at the Front. Without this joint action it would have been impossible for us now to maintain our leading position, and it would be well for us to place work of this kind on a sound financial basis.

Although most of our scientific and industrial progress has been achieved by individual concentration, yet there are many problems of the utmost importance to the nation and the Empire which can only be solved by national effort. I view, therefore, with much pleasure the growing appreciation of science and industry shown in this time of war by H.M. the King and the members of our Government. Professor Unwin, in a recent able and stimulating address, quotes the well-known remark of Bagehot, made many years ago :—

"We English are always grumbling at ourselves. But, after all, England is a success in the world; her career has had many faults, but it has been a fine and winning career on the whole."

I would plead with our "professional whimperers" to take a more cheerful and just view of the achievement and stability of our common country, and to moderate their gloomy joy in depreciation.

Even Germans have had occasion to change their views of England. In a recent issue of a Munich paper it is stated :—

"France, though bleeding from a hundred wounds, will not give way one inch. Russia, which has been declared exhausted so often, is silently stamping ever new million armies out of the ground. England, which wields its old dominion of the seas more powerfully than ever, has taken up the fight on land against us with incredible energy and self-sacrifice. Against us stand not only colossal material, but immense intellectual and moral forces."

So the Germans are awakening to a consciousness of the futility of their dream of domination founded upon the idea of might irrespective of the rights of other nations, and they will ultimately be forced to accept the idea so strange to them hitherto that honesty between nation and nation is as necessary as between man and man.

Britain's stability in the future as in the past will flow from continued honesty and fair play, and her material success from consideration of the interests of the whole world as well as her own.

APPENDIX.

EXTRACTS FROM PAPER ON "BRITISH AND GERMAN EXPORT TRADE BEFORE THE WAR."

By H. H. O'Farrell.

From "The Economic Journal," June, 1916.

. . . . It is proposed in the present paper to deal only with the exports of the United Kingdom and of Germany between the years 1895 and 1913—the last year for which we possess complete information as to Germany's foreign trade.

This period of nineteen years may conveniently be grouped into averages of four periods—three of five and one of four years. The first figures to be noticed are those of the total foreign trade (exclusive of bullion), which are as follows :—

Total Exports (Millions of £).

	Average of 1895–99	1900–04	1905–09	1910–13
United Kingdom .	300·0	356·6	462·5	581·2
Germany	197·9	251·8	340·1	460·0
Balance in favour of United Kingdom .	102·1	104·8	122·4	121·2

These figures, as well as those to be subsequently given, do not include the exports of the United Kingdom to Germany, or *vice versâ*. The direct trade between the two countries has been excluded in order to deal only with competition in foreign markets. The preponderance of British exports in the first period is really slightly greater than appears above, since the export of new ships was first included in the British statistics in the year 1899, while it found a place in the German figures two years earlier. . . .

The figures of the total trade of both countries give due weight to the re-exports, which form one of our most considerable commercial assets, and their transport is really as much a domestic industry as any other. Lacking this item, the "special exports," or exports of the domestic produce of the United Kingdom, appear in a less favourable light in comparison with those of Germany.

SPECIAL (DOMESTIC PRODUCE) EXPORTS (MILLIONS OF £).

	Average of			
	1895-99	1900-04	1905-09	1910-13
United Kingdom	239·6	289·2	377·4	474·2
Germany	181·3	235·6	314·2	425·7
Balance in favour of United Kingdom	58·3	53·6	63·2	48·5

So far, the results appear to indicate that, while our total exports have been pretty well maintained throughout, there has been a not inconsiderable falling behind in the case of the purely domestic exports in the last of the four periods. It is to be observed, however, that this is not due to any slackness on our own part—for the increase of British exports is more than maintained throughout—but to a special spurt which our rival appears to have made in the four years preceding the war. In the last year the German imports, which had reached a figure of over 525 millions in 1912, were nearly stationary at 529 millions, but the exports increased by more than 40 millions; the imports of bullion increased by 110 millions, and the exports of bullion decreased by about 40 millions. It may be safely conjectured, I think, that the activities of the last four years were not purely commercial.

In any case it is not sufficient to look at the figures in the lump merely. It is necessary to dissect them in order to ascertain their real significance. The first great division into which they fall is into the trade with European and non-European countries respectively. Russia will be included in the first and Turkey in the second group. Taking the European countries first, we find the figures to be as follows:—

SPECIAL (DOMESTIC PRODUCE) EXPORTS TO EUROPEAN COUNTRIES (MILLIONS OF £).

	Average of			
	1895-99	1900-04	1905-09	1910-13
United Kingdom	64·5	76·2	97·4	121·6
Germany	100·3	128·7	179·6	255·9
Balance against the United Kingdom	35·8	52·5	82·2	134·3

The superiority and uniform progress of Germany as regards the trade with European countries is clearly indisputable.

On the other hand, when we look to the trade with the rest of the world outside the Continent of Europe, we shall find a still more remarkable superiority on the side of the United Kingdom. The figures are as follows:—

SPECIAL (DOMESTIC PRODUCE) EXPORTS TO NON-EUROPEAN COUNTRIES (MILLIONS OF £).

	Average of			
	1895-99	1900-04	1905-09	1910-13
United Kingdom	152·6	188·4	246·0	313·3
Germany	45·3	60·7	83·5	110·4
Balance in favour of United Kingdom	107·3	127·7	162·5	202·9

The broad conclusion to be drawn from these figures would seem to be that, as regards the Continent of Europe, Germany had a great superiority, obviously due to her central position and to her magnificent railway and water communications with the countries by which she is surrounded; while we, on the other hand, had an even greater advantage as regards the rest of the globe in our ocean communications and in the increasing magnitude and efficiency of our mercantile marine. The Continent, in the pre-war days, was becoming more and more the *hinterland* of the German railways, while the overseas countries of the world remained in increasing measure the sphere of influence of British sea supremacy. The contest has been between land carriage and carriage by sea, each exploiting the field most favourable to its activities. . . .

Another point which is noteworthy is that the trade of both countries increased *pari passu* throughout the period, and that neither seems on the whole to have gained at the expense of the other. Germany did not, so far as the figures disclose, oust us from any trade that we possessed before, nor we Germany. Out of an increasing volume of trade Germany obtained the major portion of the excess in Europe, Great Britain in the rest of the world. With the exception of certain years just after the South African War, and the two years of the American crisis and its aftermath (1908–09), there is no instance of a positive decline in British exports synchronising with a contrary movement in German exports. This is the more remarkable considering the strenuous efforts which Germany is well known to have been making to extend her foreign trade. . . .

With the exception of the United States and Mexico, where Germany competes with us on approximately equal terms, there appears to be no non-European country in which British exports are not considerably in excess of German. The preponderance is accentuated in the case of our overseas possessions and Dominions, but is by no means confined to them. . . .

On the whole, the figures we have now passed in review are by no means discouraging, and it must be remembered that they reveal nothing of the quality of the trades compared. British commerce, it may safely be assumed, is always carried on with a view to more or less immediate profit. There is reason to suspect, on the other hand, that much German trade has been merely the seed-corn of a speculative harvest, destined, it may be hoped, never to mature. But, taking the figures at their face value, the result would seem to be to dispel exaggerated notions of German competition. Great as German progress has been in the past, British progress has been greater. There is unquestionably much room for improvement; for better organisation, for more businesslike methods, for

a larger appreciation and a more liberal endowment of research; but the vision of an all-conquering Germany has not been true in the past, and assuredly should be even less possible in the future.

After delivering the address, the Chairman presented the Society's medals, which were awarded for papers read during last Session.

At the Ordinary Meetings:—

J. Arthur Hutton, "The Effects of the War on Cotton-Growing in the British Empire."

George Percival Baker, "East Indian Hand-painted Calicoes of the Seventeenth and Eighteenth Centuries, and their Influence on the Tinctorial Arts of Europe."

In the Indian Section:—

James MacKenna, M.A., I.C.S., "Scientific Agriculture in Europe."

In the Colonial Section:—

Sir Sydney Olivier, K.C.M.G., "Recent Developments in Jamaica: Internal and External."

Sir Robert A. Hadfield, F.R.S., in proposing a cordial vote of thanks to the Chairman for his address, said he had never heard a more lucid, more clear and better expressed discourse. The subject with which it dealt was a very wide one, but those present would be able to take away with them a broad and comprehensive view of the future of this great country. Personally he was thankful to say he was an optimist; like the Chairman, he had never felt that this country would not be able to hold its own in the future. If the people were true to themselves, the nation would continue to expand and have a bigger share in the concerns of the world even than they had had in the past. The Chairman had alluded, among other things, to the interesting question of hours of labour. Personally he hoped that some day a forty-eight hours' week would be established. Speakers often expressed an opinion from theoretical considerations, but he was able to speak from something like twenty years' experience in his works in the north of England, where forty-eight hours a week had been worked with, he was thankful to say, great success. The subject was very much in the air at the present time, and he thought a forty-eight hours' week had come to stay permanently. He specially referred to the subject because he thought it was the duty of the employer to convince the employee that he had his interests at heart. It was an old-fashioned principle to expect an ordinary human being, brought up under modern developments, to be at work before six o'clock in the morning. His own workmen came after they had had breakfast, and he was quite confident that much better work was obtained from them as a result of that little privilege, which was highly esteemed. He was very glad the Chairman had referred to the admirable paper by Mr. O'Farrell. It was very unfortunate that the excellent papers read before the Statistical Society, about whose work sufficient was not known, were not brought more generally before the notice of the members of the public.

Sir George R. Askwith, K.C.B., K.C., D.C.L., in seconding the motion, said that, like the mover of the vote, he was on the optimistic side. In the course of his address, the Chairman had alluded to the fact that after the war wages should be raised, and secondly, in order to get that increase of wages, there must be an increase of production. It had been his duty, during the last two and a half years, to deal with very large increases of wages, amounting in nominal value to millions upon millions of pounds, and affecting hundreds of thousands of human beings. At the beginning of the war it was feared that in certain sections of trade there might be a great amount of unemployment and a great loss of wages. That fear had not come true, but it was some time before the doubt was dispelled. It was possible that at the end of the war a period of doubt, hesitation, and adjustment might again ensue; but after that, and even during it, he looked forward to a period of production, and of the necessary reinforcement of the waste that had taken place, which would lead to an increase of, or at any rate the maintenance of, wages, and the desire to maintain those wages would also lead to an increase of production. It had been a very bitter thing indeed for many trade unions to give up rules, regulations, and ideas that they had been working for for a quarter of a century or more, but some of them in a surprising manner had adjusted those rules and regulations, and where they had done so upon right lines the result had been to the satisfaction of most of the individuals who composed them; and he doubted whether some of them would ever go back to the policies and to the rules which existed before the war. The Chairman had also referred to the importance of women taking a part in various branches of industry. That, it was obvious, would be practically a necessity for this country, but if the women were to go into industry other than that connected with munitions, where wages were at present high, it would be necessary for the employers in different branches of industry to realise that they were not likely to be drawn to them unless the wages were made sufficiently attractive to induce them to give up a life of idleness or withdraw from pursuits that they liked better. The Chairman had mentioned that this country had gained a great deal of its power by waiting until it was seen what the facts were, and the circumstances became visible. He hoped the "wait and see" policy would not be carried too far, because it was a dangerous thing to "wait and see" too long, until the nation went to sleep, did not realise what the circumstances were, and did not provide in time for them. It was necessary to look forward and to organise, and then he thought this country would maintain the great position it had already achieved, and rise even to a higher plane.

The resolution of thanks was put to the meeting by SIR ROBERT HADFIELD and carried unanimously.

THE CHAIRMAN, in thanking the mover and seconder for their appreciative words, and the members for the heartiness with which they had received them, said he quite agreed with Sir George Askwith that they must not "wait and see" too long.

The meeting then terminated.

ENGINEERING NOTES.

The Oil Shales of Norfolk.—Mr. W. Forbes-Leslie recently read a paper on the above important and opportune subject at the Institution of Petroleum Technologists, in which he discussed, among many interesting facts regarding the geological parts of the question, the matter of the origin, especially as to the Puny Drain geological series. The organic contents of the shale common to that formation are remarkably constant in amount throughout the series, both along the outcrop and on the dip. The oil in the Puny Drain shales appears to be derived from two different sources—first from indigenous material, possibly of animal origin, and, secondly, from a source of free oil. Whether this is formed *in situ* as the result of the natural distillation of more deeply-seated shale beds and the rise of the resulting volatile products into the superficial and superincumbent beds, which are now exposed, or whether, as seems more probable, it comes from a source of liquid oil confined at a high pressure beneath the series, it is not yet possible to demonstrate. That free oil does exist is clearly shown by three classes of evidence: First, as much as 1 per cent. of oil is dissolved when the shale is treated with ether; second, from the prospecting side, when the limestone capping is penetrated, water covered with oil appears in the sinking, or when a piece of shale recently broken out from the bed is subjected to running water the oil is seen to escape and form a scum on the surface; and third, when the shale is treated in retorts it is found that the greater part of its oil contents comes off at a temperature under 300° C. The oil obtained from both series of shales is golden black in colour, with a purplish tint in reflected lights. It is very fluid, running almost like water, despite the fact that its specific gravity is as high as ·942 to ·960. In this respect it differs from the Scotch shale oil, which is dark green in colour, with a specific gravity of ·860 to ·890, and very viscous, with a settling point of about 32° C. Norfolk shale oil differs likewise from oil derived from the Dorset-Kimmeridge series, both in colour and in viscosity. The specific gravity of the motor spirit of petrol obtained from redistillation of the oil is ·855, with a low flash-point; Scotch shale naphtha has a specific gravity of ·734. Bulk tests carried out on Puny Drain shales, both in the field works erected near the outcrop and in works under the supervision of engineers appointed by financial interests, gave highly satisfactory results. The yield of oil on a commercial basis was 40 gallons to the ton, the nitrogen content was about 1 per cent., and the yield of sulphate of ammonia was 66 lb. per ton; while there was obtained 25,000 cubic feet per ton of dry gas possessing highly illuminating properties. Sulphur contents were as high as 6·4 per cent. The oil obtained on these bulk tests had a high specific gravity, namely, ·942 to ·960, and was very fluid. The yield of fractions coming within the limits of the motor spirit series is considerable. In addition, the oil yields from 3 to 4 per cent. of bases extracted by weak acids, 3 to 4 per cent. of crude phenols, cresols, etc., and 3 to 4 per cent. of benzol and toluol. The main interest of these bulk trials is the extremely low temperature at which the shales yield a big proportion of their oil contents, and that the residues contain 20 to 27 per cent. of carbon, fixed and unfixed. The quantity of the sulphur contents varies from 4·32 to 7·8 per cent. Here the shale conforms to the known sulphur contents of the Kimmeridge series generally. Mr. Forbes-Leslie points out that much has been made of the sulphur difficulty, and gives many instances showing its practical unimportance.

Equipment for Thawing Frozen Pipes.—A thawing outfit, put into service lately, has enabled the St. Paul, Minnesota, Waterworks Department to thaw out any frozen water service on which it has been tried within a maximum of fifteen minutes. The apparatus consists of a gasoline engine direct-connected to a generator, a switchboard and a reel of cable, the whole mounted on a structural steel frame, so that it can be handled as a unit. The four-cycle, four-cylinder gasoline engine, built by the Capitol Engine Works, St. Paul, is direct-connected by a leather-link flexible coupling to a Roth Brothers 20 kw. 40-volt direct-current generator. A voltmeter, an ammeter, a rheostat and a single-pole knife switch of 500 ampere capacity are mounted on the switchboard. The reel holds 500 ft. of extra flexible copper cable of 300,000 circ. mils cross-section, in 100-ft. lengths. Each length is fitted with terminal lugs. The various parts of the equipment are securely attached to the steel frame, making the equipment easily portable. For service the equipment is mounted on a Troy trailer of 1½ ton capacity, which is hauled about by a motor truck. The mounting is not permanent, and after the winter season the thawing unit will be removed and the trailer used for other purposes. To thaw out a service one pole of the generator is connected, in the premises, to the pipe between the meter and the street main.

The other pole is connected with the nearest fire hydrant. Thawing is effected in from five to fifteen minutes after the current is turned on.

The South African Ports.—The South African Government, which have the whole of the ports under their charge, give the following account of their works. The harbour at Cape Town consists of a large outer dock, 67 acres in area, known as the Victoria Basin, and a smaller dock of 8½ acres. As the result of dredging operations now in hand with the Victoria Basin, it is hoped to increase the average depth of the dock to 36½ft. The authorities have under consideration the adoption of a comprehensive scheme, estimated to cost £3,000,000, which makes provision for eight large additional berths, with a depth of water alongside of 40 ft., and able, therefore, to accommodate vessels of the largest size. The want of adequate ship-repairing facilities at Cape Town is partly redressed by the arrangement whereby the large Admiralty dry dock at Simonstown may be used for commercial work. The gradual conversion of Port Natal into a first-class harbour represents an engineering triumph over great difficulties. In 1902 the average low water depth over the entrance bar was between 18 ft. and 19 ft.; it is now nearly 36 ft., and alongside the wharves on the Point, the shipping area of the harbour, the depth of water at low-water spring ranges from 22 ft. to 38 ft. 6 in. At the bunkering station on the Bluff considerable extensions have been made to the loading plant, and electrically-operated belt conveyors are now being installed to bring the facilities in line with the most modern practice. At the Congelle Wharf site great developments are foreshadowed, including an important reclamation with the object of extending the wharfage accommodation, providing industrial sites, and attracting new branches of manufacture. The facilities for both the export and the import trades have been admirably planned, and the years immediately following the war are expected to be a period of considerable commercial expansion at Durban. Algoa Bay, from the fact that it can be made and entered in all weather, is the refuge harbour of South and East Africa. It is not a bunkering port, but has good accommodation otherwise, and enjoys excellent railway facilities. The port of East London, commonly known as Buffalo, has recently made good progress. At the present time an important scheme of improvement is being carried out. The work in hand includes the construction of nearly 3,000 ft. of new concrete breakwater, the deepening of the entrance channel, and the provision of deeper water alongside quays. Until a comparatively recent date the principal shipping centre was on the east bank of the river, but the west bank is now becoming the chief shipping area. The west quay, which has been completed only recently, is a solid stone and concrete structure over 1,000 ft. in length. At Mossel Bay a reinforced concrete jetty has been recently constructed for the accommodation of passenger traffic. The jetty, which is 500 ft. long and 60 ft. wide, is protected by a breakwater 320 ft. long, which has been built out from a stone wharf constructed on reclaimed land on the eastern side of the new jetty. The total capital expenditure on the five ports has been in excess of £10,000,000. The *Times* is our authority for these details.

The Winnipeg River, Canada, and its Resources.—A report on "The Winnipeg River Power and Storage Investigations," by Mr. J. T. Johnston, was recently issued by the Water Power Branch of the Canadian Department of the Interior. The report, of which the following is an abstract, shows that power is now being produced at two of the nine possible power sites which exist on the Winnipeg River within the province of Manitoba. The older installation of the two is that of the Winnipeg Electric Street Railway Co., and is situated about fifty-eight miles in a direct line from the city of Winnipeg on the Pinawa Channel, into which a portion of the flow of the main river is directed by means of diversion weirs. The plant, which was practically completed in 1906, comprises nine main turbines, each connected direct to a 2,300 volts three-phase generator. For transmission to Winnipeg the voltage is transformed up to 60,000 volts, and the power developed amounts to about 28,000 h.p. The second installation is that of the city of Winnipeg at Point du Bois, where the first section of plant, completed in 1913, consists of five main units, each coupled to a 3,000 k.v.a. generator. In 1914 three larger turbines were erected, each coupled to a 5,000 k.v.a. generator, and producing, like the older machines, three-phase current of 6,600 volts, 60 cycles, which is transformed up to 66,000 volts for transmission to Winnipeg, seventy-five miles distant in a direct line. These eight machines yield about 25,000 h.p., but with extensions a maximum of 77,000 h.p. can be obtained. Thus at present about 53,000 h.p. (expressed in terms of 24 hour h.p at 75 per cent. efficiency) is being obtained from the river and transmitted for use in and around the city of Winnipeg. This amount is only about one-eighth of that which, according to the report, could be obtained were the other seven sites fully exploited and the river regulated, as is thought quite feasible, to maintain a minimum flow of 20,000 cubic feet per second in the power reach in Manitoba. If the latter condition were fulfilled the total that could be developed is put at 418,500 h.p., but even with the present minimum unregulated flow of 12,000 sec. ft. nearly 250,000 h.p. could be obtained. There

are seven sites enumerated in the report. To a large extent the river is composed of deep, broad basins with, but little current, broken by abrupt changes in level at the various falls and rapids. The drops are generally well concentrated and the hydraulic gradient between them usually negligible, and this combination of circumstances renders possible the utilisation for power purposes of practically the whole fall of the river. The reach below the Lower Seven Sisters and the Pinawa Channel are the only sections in which it has been necessary to sacrifice any considerable portion of the drop. The total capital cost of developing these seven sites, the power being placed on the low-tension switchboard in the power stations, is put at £2,664,000, with a 12,000 sec. ft. flow, and at £4,909,000 with a 20,000 sec. ft. flow. The corresponding annual working costs are estimated at £258,000 and £483,000, equivalent to a mean, based on the power output, of 0·065*d.* and 0·059*d.* per kw. hour with 100 per cent. load factor, and of 0·13*d.* and 0·118*d.* per kw. hour with 50 per cent. load factor. The first power undertaking to acquire rights and begin construction operations on the river since the organisation of the power survey is the Winnipeg River Power Company, controlled by the same interests as the Winnipeg Electric Railway Company, which has arranged to exploit the Du Bonnet site under the name of the Great Falls Development. It offers an excellent illustration of the manner in which the interests of the investor and of the public are served by a careful and thorough investigation of a river's power resources and by a predetermined scheme of power development conserving fully all the head capable of economical development. The surveys carried out by the department enabled the company to take immediate action for the construction of the station as soon as authority was received, without the necessity of carrying on long and expensive preliminary surveys, while the interests of the public were served by the preservation of a profitable power site at the McArthur Falls, which under the first proposals of the company would have been rendered uneconomical of development. The provisional plans of the power station at Great Falls provide for the ultimate utilisation of the whole of the regulated flow of the river, by means of eight 21,000 h.p. turbines, each running at a speed of 163·3 revolutions per minute and requiring 4,100 cubic feet of water a second under a head of 56 ft. These will drive eight electric generators, each having a normal rating of 11,000 kw. at 30° C. (86° F.) with a continuous overload capacity of 50 per cent. These machines will generate three-phase current at 12,000 volts, 60 cycles, which for transmission to Winnipeg will be transformed up to 110,000 volts by means of five banks of transformers, each consisting of three single-phase transformers. In the first instance, four complete generating units are to be installed, but the hydraulic works, including dams, sluices, building, gates, etc., will be so far completed that any of the four remaining units may be put in place without further construction work beyond that required for their actual installation.

OBITUARY.

Sir Walter Vaughan Morgan, Bt.—Alderman Sir Walter Vaughan Morgan died on the 12th inst. at his residence in Whitehall Court.

He was educated at Christ's Hospital, and on leaving school he obtained an appointment in the National Provincial Bank of England, and by the age of twenty was a chief cashier in their Manchester branch. In 1855 he left the bank to join five of his brothers in business in the City of London. They founded the Morgan Crucible Works at Battersea, and established two trade journals, the *Ironmonger* and the *Chemist and Druggist.*

Sir Walter's municipal career began in 1892, when he was elected Alderman of Cordwainer Ward. In 1900–1 he served the office of Sheriff, and in 1905, when he was seventy-four years of age, he was chosen as Lord Mayor. At the close of his Mayoralty he was created a baronet, and he also received the insignia of high grades in the Legion of Honour and other foreign Orders. He was a great traveller and a man of wide benevolence and charity, and he and his brothers devoted a considerable portion of their large incomes to purposes of philanthropy.

He was elected a member of the Royal Society of Arts in 1889.

GENERAL NOTES.

Board of Education Examinations in Science and Technology.—The Board announce that no Lower General Examinations will be held in 1917, but they hope to be able to hold the Higher General Examinations in that year, and they would be conducted in accordance with the regulations and syllabuses which governed the conduct of those Examinations in 1915 and 1916. Should it, however, prove necessary at a later date to suspend the Examinations, the Board will endeavour to give as long notice of the change as possible. After 1917 no Higher General Examinations will be held in Pure Mathematics, Theoretical Mechanics (Solids), Theoretical Mechanics (Fluids), Heat, Magnetism and Electricity, Organic Chemistry, Coal Mining and Metallurgy. The conditions governing the award of Scholarships, Exhibitions, etc., in Science in 1917 are being announced separately.

Estimated Yield of Hops in England.—A preliminary statement recently issued by the Board of Agriculture and Fisheries, estimates the total production of hops in England in 1916 at 307,844 cwt., as against 254,609 cwt. in 1915. The area under cultivation as returned on June 4th in 1916 and 1915 was 31,352 and 34,744 acres respectively. The estimated average yield per acre this year, viz., nearly 10 cwt., is about 2¼ cwt. above that of 1915, and ¾ cwt. above the ten years' mean.

Vegetable Dyes.—The value of logwood at the present time is well realised, but unfortunately, says the *Colonial Journal*, it takes a long time to produce it. The price was good in the nineties of last century, but declined so much that cultivation was largely abandoned. The trees are easily planted, and Jamaica, the Leeward and the Windward Islands are very suitable. The price before the war was £2 10*s*. to £3 per ton, and has risen to £8 10*s*. Imports into the United Kingdom have recently been below those of 1910 and 1911. Jamaica chiefly sends logwood extract, of which the value in 1914 was £172,582. Fustic, from which a yellow dye is obtained, also thrives in the West Indies, and annatto and turmeric are frequently grown. Possibly the efforts which are being made in this country to increase the supply of dyes will lead to greater demands for these products, but it has to be established that really satisfactory results can be obtained from them before they can permanently displace aniline dyes.

German East Africa.—There is a good deal of difference of opinion as to the commercial value of German East Africa. There is much rather poor land, says the *Colonial Journal*, but in so great an area this is not very material, as there is abundance of first-class country, both for agriculture and for stock. The comparison with our own territory should be as to the use which has been made of the land. Thus, sisal has been a remarkable success in the German territory, but this was largely owing to the fact that the Germans produced the best decorticating machinery. The highlands there are lower than our own, but the altitudes of British East Africa are responsible for so many cases of nervous disturbance that this may not be a disadvantage. An important point is the supply of labour, and this is reputed to be more plentiful and better in the German colony. Migration from the south will naturally tend to stop there if it finds the British flag in possession, and in time the Boer settlement would receive substantial additions. German East Africa has become a very important producer of fibre. In 1915 it exported in sisal fibre alone a value of £750,000, and the production was growing at a very rapid rate. No British colony produces fibre suitable for making twine except New Zealand, which only furnishes 20,000 to 30,000 tons out of 250,000 tons which the world requires. Most fibre is produced in Mexico and the Philippines, but German East Africa was fast becoming a valuable source of supply of this necessary product. Very little sisal fibre is used in this country, but London merchants bought largely from Hamburg, and sold to the bindery twine manufacturers in the United States.

MEETINGS FOR THE ENSUING WEEK.

Monday, November 20...Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. Address by the President, Dr. C. Carpenter, on "Chemistry and Engineering."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. and Mrs. W. S. Routledge, "Easter Island."

Tuesday, November 21...Swiney Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture IV.)

Petroleum Technologists, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Messrs. E. L. Lomax, A. E. Dunstan, and F. B. Thole, "The Pyrogenesis of Hydrocarbons."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. J. J. Ball, "Keadby Bridge."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Dr. G. H. Rodman, "On Pollens and the Fertilization of Flowers."

Zoological Society, Regent's-park, N.W., 5.30 p.m. 1. Mr. A. Ezra, "Lantern Exhibition illustrating a Hunting Trip in Central Asia." 2. Professor B. Petronievics and Dr. A. S. Woodward, "On the Pectoral and Pelvic Arches of the London specimen of *Archæopteryx*." 3. Mr. P. F. Cummings, "Studies on the Anoplura and Mallophaga, being a Report upon a collection from the Mammals and Birds in the Society's Gardens." (Part II.) 4. Lieut.-Col. J. M. Fawcett, "Notes on a Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911-13."

Colonial Institute, Hotel Cecil, Strand, W.C., 4 p.m. Professor F. Watson, "Richard Hakluyt: a Pioneer of Colonisation."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Address by the President, Sir Bernard Mallet.

Wednesday, November 22...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Mr. L. Urquhart, "The Financial Position and Economic Development of Russia."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Dr. J. H. Rose, "Carlyle's 'French Revolution.'"

Thursday, November 23...Swiney Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture V.)

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. A. H. Pollen, "The Jutland Victory."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. J. S. Peck, "The Parallel Operation of Electric Power Stations."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Address by the President, Mr. F. E. Wentworth-Sheilds.

Friday, November 24...Swiney Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture VI.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

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FRIDAY, NOVEMBER 24, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 27th, at 5 p.m. (Howard Lecture.) JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." (Lecture I.)

WEDNESDAY, NOVEMBER 29th, at 4.30 p.m. (Ordinary Meeting.) DUGALD CLERK, D.Sc., F.R.S., "The Internal-Combustion Engine." The HON. SIR CHARLES A. PARSONS, K.C.B., LL.D., D.Sc., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Friday, the 17th inst. Present:—

Sir William Duke, K.C.S.I., K.C.I.E. (Chairman of the Committee); Sir Arundel T. Arundel, K.C.S.I.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.; William Coldstream, B.A., I.C.S., retd.; Sir Frederic W. R. Fryer, K.C.S.I.; Sir Henry Evan M. James, K.C.I.E., C.S.I.; Charles Campbell McLeod; Sir John Ontario Miller, K.C.S.I.; Colonel Charles Edward Yate, C.S.I., C.M.G., M.P., with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, C.I.E., Secretary of the Section.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 22nd, 1916; The RIGHT HON. LORD CARNOCK, G.C.B., G.C.M.G., G.C.V.O., K.C.I.E., British Ambassador in Russia, 1906–1910, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Chrimes, Charles, Holmcroft, Wilbury Villas, Hove, Sussex.

Hansard, George Albert, B.Sc., LL.M., Auckland, New Zealand.

Lindsay, Stuart Currie, P.O. Box 830 Victoria, British Columbia, Canada.

THE CHAIRMAN said he felt highly honoured at having been invited to take the chair on this occasion, and to have the opportunity of introducing his friend Mr. Leslie Urquhart, who had kindly consented to give a paper on "The Economic Development of Russia and Britain's Interest therein." There was no one more competent than Mr. Urquhart to speak on this question, because he had been one of the most energetic and zealous promoters of the use of British skill and industry in assisting in the utilisation of the vast resources of our gallant ally, the Russian Empire.

The paper read was—

THE ECONOMIC DEVELOPMENT OF RUSSIA AND BRITAIN'S INTEREST THEREIN.

By LESLIE URQUHART.

The object of this paper is, firstly, to consider the Russian internal and external financial position, and forecast what it is likely to be if the war lasts another year; secondly, to review the industrial resources of the Russian Empire to meet that position; thirdly, to consider the readiest means of developing those resources; fourthly, to show in what way this development is likely to interest and attract British capital; and, lastly, but not least important, what are the moral forces which will bring about the rapid development of those resources.

FINANCE.

From the international point of view the question of the amount of Russian foreign indebtedness is one of great importance, as it concerns the question of Russian financial stability and credit in the comity of the nations of the world; and to this country especially it is a matter of intense interest, as we are steadily becoming, and will be if the war lasts another year, Russia's largest creditor.

The Russian Minister of Finance on October 17th last, when giving an outline of the Budget for 1917 before the legislative bodies, stated that war expenses (which were not included in the Budget of revenue and expenditure) for the two years of the war to August 1916 aggregated £1,772,000,000. In order to obtain some idea of what the National Debt may be if the war lasts, say, to the end of October 1917, it can be estimated on the basis of figures given in the Budget that this will add another £1,635,000,000. Thus the total national indebtedness will have

increased by £3,407,000,000, in addition to the £882,000,000 National Debt on January 1st, 1914.

The national revenue and expenditure before the war was about £350,000,000. Notwithstanding the loss of some £60,000,000 by the abolition of the spirit monopoly, the amount estimated to be obtained according to the State Budget for 1917 is £400,500,000, thus giving evidence of the country's resources. The vodka prohibition had an immediate effect, and was the direct cause of greatly increasing the savings of the people. The average increase in Savings Banks deposits for ten years before the war was under £10,000,000 per annum. Since the prohibition the total increase in deposits for 1915 was £80,830,000, and for the first six months of 1916, £98,630,000. The total deposits at July 1st, 1916, amounted to £320,000,000, and securities deposited £110,000,000.

This increase is a small proportion of the increased savings of the nation, as savings banks before the war were only established in populated centres, and not in every large village in the country. Measures are being taken greatly to increase the number. The people's savings are at the disposal of the Government, and to a great extent can be used for the development of the country. Cessation of the vodka monopoly, therefore, has increased efficiency, and has put more money into the National Exchequer than could ever have been obtained by revenue derived from the sale of vodka.

Granted that the war is over by the autumn of next year, and that the Russian National Debt will be about £4,300,000,000, additional taxation will have to be imposed to provide for interest and sinking fund, combined, say, 5½ per cent., calling for, say, £220,000,000 per annum over a period of years. It is probable that the capitalisation of pensions to families of those killed and maimed, and compensation to those who have suffered by the war, and for the reinstatement of railways and devastated districts, will call for, say, £50,000,000 per annum, making the total increased taxation caused by the war, say, £270,000,000, of which £50,000,000 is already provided for by the increase in the 1917 Budget.

It cannot be denied that the present state of development and trade of the Empire will make this additional burden of taxation heavy for the people to carry, but the rapid development of means of communication and growth of trade and industry will make it possible for the boundless wealth of the country gradually to liquidate the debt caused by the war.

A comparison of the aggregate amount of the State debt of various Powers and the *per capita* indebtedness of each individual citizen as at January 1st, 1913, shows:—

Countries.	Total at 2*s.* per rouble. £	Per head. £	*s.*	*d.*
France	1,166,575,000	29	10	0
Germany	955,971,000	14	12	0
Russia	895,787,000	5	6	0
Austria-Hungary	696,070,000	13	10	0
United Kingdom	679,587,000	14	16	0
Italy	503,601,000	14	10	0
Spain	352,479,000	17	18	0
Portugal	176,640,000	29	12	0
Belgium	104,464,000	21	10	0
Holland	94,041,000	15	0	0

It will be seen, therefore, that the Russian National Debt is the lowest per head of population of any country in Europe.

Exchange and Trade Balance.

The fall of the exchange value of the Russian rouble during the war by about 30 per cent. has been greatly accentuated by the blocking of the Black Sea. The principal items of export from Russia are low-value crude products and foodstuffs: wheat, timber, eggs, butter, etc., which cannot stand high freights. The exports through the northern port of Archangel, which is frozen up for some months in the year, or through Vladivostok in the Far East, were small, while the imports of high-priced machinery, munitions, and equipment for army and fleet have been enormous. The result shows a large trade balance on the wrong side, which for 1914 amounted to £14,000,000; while in 1915 this had risen to £66,000,000.

Similar increases in imports over exports may be noted in other countries; but rich countries, which have capital placed abroad have interest in gold payments on this capital coming in to restore the balance, and the trade balance on the liability side becomes a financial balance on the assets side, which contributes to maintain the exchange.

Great Britain, according to a statement made by Mr. Lloyd George, has investments in the colonies and foreign countries aggregating £4,000,000,000 sterling (this figure is probably underestimated), and the yearly revenue from this capital equalled about £200,000,000.

The international exchange value of the monetary unit, which is the criterion of the intrinsic valuation of the financial position of any country, must, of course, finally depend on the balance of foreign trade in favour of that country, and of the import or export of gold, as international exchange does not recognise any

other medium of payment in adjusting the balance of foreign trade.

What is Russia's position in this respect? According to the statistics of the Russian Ministry of Finance, the foreign indebtedness of Russia before the war exceeded £500,000,000, requiring a yearly payment abroad of over £25,000,000. To this has to be added interest, etc., of municipal, private railway, and company issues, and private indebtedness, also short-term credits granted by foreign banking establishments. In view of the insignificance of Russia's merchant shipping, Russia pays abroad large sums of money for sea freight; and, finally, considerable sums are expended abroad by Russian travellers who visit health resorts.

Debt Service Payments Abroad.

It is impossible to estimate accurately such payments, as they cannot be exactly known even by the Government; it would certainly not seem an exaggeration to take this at £20,000,000, which, together with the £25,000,000 interest payable abroad on the Foreign Debt of the State, brings the total yearly payments of the nation on foreign capital indebtedness to, say, £45,000,000. Russia's total borrowings abroad since the beginning of the war had by October of 1916 grown to somewhat over £500,000,000. It is probably not an over-estimation to reckon that should the war last another year Russian foreign indebtedness to the end of October 1917 will reach, say, £900,000,000: the greater part of this will be due to Great Britain. It should be mentioned that the new as well as the old foreign debt is included in the total of the National Debt previously estimated at £4,300,000,000. If we take it, therefore, that before the war the annual payments abroad were, say, £45,000,000, and that by the end of October 1917 Russian foreign indebtedness will have increased by another £900,000,000, necessitating the payment in interest and sinking fund at, say, an average of 5½ per cent. per annum, of £50,000,000 a year, the total payments due abroad after the war will be not less than £95,000,000 per annum. These calculations are, of course, assumptions, and cannot be taken as definite; but they are based on the best information that could be obtained, and for the purposes of this paper may serve to give some idea of what the future position is likely to be.

For the covering of £45,000,000 payments abroad before the war the only item available was the excess of Russia's exports over imports, which during the period from 1908 to 1912 showed an average of some £35,000,000 per annum. It follows, therefore, that if the balance of foreign trade after the war remains at only what it was before the war the adjustment of the financial balance-sheet will require payments abroad in gold to the extent of some £60,000,000 per annum.

The production of gold in Russia is, on an average, only about £6,000,000 per annum. For the adjustment of the foreign financial balance-sheet, therefore, one of two methods only could be adopted: either to export the gold in the hands of the Government Treasury, or to contract new debts. The country cannot permit the export of gold, as this would cause the dislocation of the gold currency and the disorganisation of the whole of the economical and financial system of the country. To adjust foreign accounts by means of an increase of foreign indebtedness at the end of the war, when almost all Europe will be in need of finance, will certainly be difficult. There only remains, therefore, one remedy for Russia, and that is to increase exports generally, to increase to the maximum the value of her exported products; to export not crude, but high-priced manufactured or semi-manufactured articles; and, further, in order to keep her gold in the country, to purchase nothing from abroad which she can produce at home. This policy, which is undoubtedly the policy of the nation and the Government to-day, and is urgently called for by the necessities of the nation, will, if carried through without delay, create in a very short time a flow of gold into the country, will gradually liquidate the paper currency and reinstate the gold currency, and will restore the international or purchasing value of the rouble to its normal rate.

The Exports.

A summarised analysis of official returns of the average yearly value of exports for five years from 1909 to 1913 (the values being fairly constant for each year) shows how predominant is the agricultural character of the country, for, of a total yearly average value of exports of £142,280,000, foodstuffs and live stock account for £90,590,000, or over 63 per cent. of the total, crude and semi-manufactured goods £49,000,000, and manufactured articles only £2,690,000 a year.

Under the heading of foodstuffs, wheat alone accounted for £67,000,000, or over 48 per cent. of the total Russian exports, and constituted the chief basis of Russian national prosperity. Nevertheless, Russian agriculture yields considerably

less per acre under cultivation than any other country in Europe to-day.

Countries.	Average for 1901-1910. Wheat. lb. per acre.	Rye. lb. per acre.	Barley. lb. per acre.	Oats. lb. per acre.
Russia (50 Governments), not including Siberia	506	626	680	640
Austria	1,133	1,093	1,200	973
Hungary	840	–	1,053	946
Germany	1,826	1,466	1,693	1,626
France	1,200	933	1,120	1,066
United Kingdom	1,986	–	1,693	1,573
Belgium	2,093	1,933	2,386	2,146
Roumania	1,053	786	853	746
Serbia	746	546	680	466
Bulgaria	653	733	706	653

Even Serbia and Bulgaria compete successfully with Russia. As regards Belgium, Germany, and the United Kingdom, they represent at present an unattainable ideal. This is not attributable in any way to difference of soil—Russian private-owned land stands on a higher level of productivity by some 25 per cent. than peasant land. But it is the peasant lands that matter and the level of the peasant masses which tells.

Germany, under approximately the same natural conditions as Russia, has been able to increase its productivity year by year, while the Russian landowner is still dependent on climatic conditions, and receives from the land what God gives him, and not what he intelligently and consistently demands of it. If, under the conditions of the past ten years, Russia produced 20·3 per cent. of the total world's harvest—and, particularly in 1907 to 1912, put on the world's market 19 per cent. of the total wheat, 24·3 per cent. of oats, 48·1 per cent. of rye, and 31·6 per cent. barley—it is clear what position Russia could occupy if her agriculture were placed on a high level. If her harvest were increased to double the quantity only, this would alter the economical position of the people and the State.

Eggs.—Eggs occupy second place in value of exports under the heading of foodstuffs. In 1910 Russia exported 1,777,000,000 eggs, to the value of £3,130,000. In 1913 there were exported 3,752,000,000, to the value of £9,639,000. The export was principally to England, which takes 40 per cent. of the whole, while Germany and Austria between them used to take the greater part of the remainder. Before the war Great Britain obtained more than half her total supply of eggs from Russia, and this importation was gradually increasing. In other words, 7,000 eggs per minute were rolling out of Russia in 1913, of which the good Russian hens were laying 2,800 eggs per minute for Britain, and they are anxious to do more.

Butter.—The Russian butter trade during the last few years has been continually increasing. In 1896 the export was only 10,000 tons, of a total value of £700,000. In 1913 exports had increased to 77,000 tons, of a total value of £7,160,000. During seventeen years the export had increased seven and a half times and the value ten times. Practically the whole success of the butter trade was due to Siberia. Great Britain in 1913 took 45 per cent. of the total export, Germany 35 per cent., and Denmark 14 per cent. On the English market Russia has only one competitor, namely, Denmark, the productivity of which country has reached its highest limit, and which supplied 40 per cent. of the total butter imported into the United Kingdom, the Colonies about 25 per cent., and Russia under 20 per cent.

Russian butter has a great future before it, not only in England, but in Germany, which received 55 per cent. of its butter imports from Russia; other European countries, as also the United States, from being exporters, are gradually becoming importers.

The Beet Sugar Industry is also becoming one of great national importance. The industry is well developed on modern lines; the yield of roots per acre and the percentage of sugar from the roots are almost on the level of Germany. The production of sugar is at present at the rate of 2,000,000 tons per annum, and can be increased very greatly. It is expected that Russia will take a predominant position in the beet sugar trade, and that eventually the production will be the largest of any country in Europe. In 1913, owing to the limitations imposed by the International Sugar Convention, only 200,000 tons of sugar were exported.

After the war the Beet Sugar Convention will doubtless, so far as Germany is concerned, be cancelled, and will permit Russia to export very much larger quantities of sugar than heretofore.

Flax.—In the growing of flax Russia occupies first place in the world, and practically monopolises the world's market. Russia collects from her fields ten times as much as all the other countries together. In 1913 her exports were valued at nearly £9,000,000. The principal importers were England, Germany, and Belgium in almost equal quantities. The yield per acre, however, owing to the primitive methods

employed, was only about half what it is in other countries.

Cotton.—The cotton fields of Central Asia and the Caucasus have been continuously increasing their production for a number of years past, and are now giving nearly 300,000 tons of raw cotton per annum. With the large areas of virgin land steadily coming under irrigation the production will continue to increase rapidly, and in future the import of raw cotton will no longer be witnessed.

The exports reviewed are the principal ones, and it would be tedious to review others.

Result of Substitution of Scientific for Primitive Methods.

The figures of yields per acre I have quoted show the immense difference between the potential possibility of Russian agriculture and the actual position. Russian agriculture in all its branches is in the primitive state. It lacks organisation and modern appliances. Further, the ground does not receive back what it gives, and the equilibrium is easily upset. In the past fertilisers have practically not been used, and only lately has any progress been made in this direction. Compared with other nations, therefore, the Russian peasant has a great deal of leeway to make up. Germany, for instance, uses 135 lb. of phosphoric acid, potash, and nitrate per acre; Holland, 160 lb.; Belgium, 328 lb.; while Russia at present only uses 6 lb. per acre. On a parallel with this is the very insignificant use of animal manure.

The fundamental reason for all this is the same primitiveness. The Russian peasant produces almost exclusively wheat, for which there has long been a demand on the world's market. Having exhausted his field, he does not go over to more intensive cultivation by fertilising the soil, but, thanks to the plenitude of virgin land, moves from the exhausted position to new areas where land is free and arable. In this manner in olden times he colonised the whole of South Russia, and at a later period occupied Siberia; but the world's increasing demand and the higher prices obtaining for produce will naturally call for more intensive exploitation of the soil, as it has done in Siberia. That the peasant is quite capable of assimilating more scientific methods once shown to him to be of advantage is proven by the large yield obtained by the peasant farmer in the growing of beetroots, both per acre cultivated and percentage of sugar obtained from the roots. The past ten years have seen a gradual process of evolution in this direction, and every year sees a greater rate of progress, as the figures I have quoted tend to show. Large works are being established on the Volga and elsewhere for the production of fertilisers. Intensive agriculture would give a surplus of corn for cattle, which again would strengthen the land, and would mean at the same time intensive breeding, which would make it possible to export meat, butter, and eggs, in ever-increasing quantities after providing amply for home requirements.

The extensive development of industries in most of the Eastern European countries, and the consequent growth of town population, has gradually decreased the production in these countries of home-grown foodstuffs per head of population and increased the necessity for imports. Russia is only commencing her industrial history. Her town population equalled in 1911 only 13·7 per cent. of the whole, while in Germany and France between 50 and 60 per cent. lived in towns, and in England nearly 80 per cent.

The Census for 1915 showed that the population of the Russian Empire had reached 182,000,000, and the yearly increase is at present about 2½ millions. Over 86 per cent. of this population lives on the land. The total area of the Empire is some 8,600,000 square miles, and the land under cultivation in European Russia is capable, as I have tried to show, of very much greater productivity, while in Asia the Empire possesses almost unlimited areas ready for cultivation. This, after all, is the sound fundamental position of the Russian Empire as a great potential producer of foodstuffs; and it may be stated that, granted certain conditions, which I will deal with later, Russia may quickly become the predominant supplier of foodstuffs and raw material of the world.

Timber.

Timber, after agriculture, occupies the second place of importance in the natural resources of the Russian Empire, and second place after wheat in value of exports, having increased from a total of 6½ million pounds sterling in 1905 to 16¼ millions in 1913. Notwithstanding this rapid increase, the exploitation of the forests in Russia is still on a primitive basis; but as regards the reserves of timber the Russian Empire occupies a unique position in the world, and Russia henceforward must become the predominant supplier of timber to the European markets.

As to timber productivity, available statistical

material enables us to divide the civilised countries into two groups: in the first of these, as shown below, are included those countries the forests of which are insufficient to cover their own needs; and in the second those countries owning such an area of forests as to enable them to export timber to the world's markets.

In the First Group are Included:

	Acres.
Germany (without its Colonies) .	34,587,000
The Balkan States	25,542,000
France (without its Colonies) . .	24,426,900
Spain (without its Colonies) . .	16,059,600
Italy (without its Colonies) . .	10,130,400
Great Britain (without its Colonies)	3,037,500
Other European Countries . . .	5,783,400
	119,566,800

In the Second Group are Included:

	Acres.
The Russian Empire (including Finland)	1,456,917,400
Canada	800,442,000
United States of America . .	606,015,000
Sweden and Norway	65,269,800
Austria-Hungary	52,868,700
	2,981,512,900

The forests in the first group contain only 4 per cent. of the timber, whereas those in the second group represent 96 per cent. of the total. Russia accounts for nearly 50 per cent. of the grand total afforestation of the world; but this does not include the vast areas of unexplored forests in Siberia. Only two of the Siberian provinces—Yakoutsk and Yenissey—represent six times the size of France and Germany together. The figures quoted do not alone give quite a definite idea of the position. The part which each country occupies in the world's market must also be taken into consideration.

The forests of Norway are not very extensive, and exploitation has been carried on for a considerable period, having been commenced in the Middle Ages. Such exploitation has resulted in the country being denuded to a considerable extent. This exhaustion is strongly reflected in the rapid decrease in exports. In 1900 Norway exported 428,671 standards; in 1913, only 223,576 standards; and in 1913 Norway imported 119,032 standards of Russian timber. During fourteen years on balance, therefore, Norway has decreased its exports of timber by about 70 per cent. Norway cannot be a serious competitor to Russia.

Sweden is in a similar position, as its exports of timber are also decreasing. In the world's market of the future Sweden will not count.

The United States for many years has destroyed its forests in the most spendthrift manner. At the present time some of the States which formerly abounded in forests are denuded. Hence the United States is compelled to import timber of every kind for the requirements of its industries. The United States Government is now taking energetic steps to preserve the forests, but the shortage of timber will necessitate resort to imports from the forests of Canada, the forests of which at the present time are in many respects inaccessible; and Canada, when the time comes, will probably have her work cut out to supply her own requirements and those of the United States. With such a position in the American continent Russian forests constitute the principal source from which the various European countries will draw to cover their ever-increasing requirements of timber. Russia is guaranteed the possibility of selling as much as she can export for many generations to come.

Of the total exports of Russian timber, Great Britain has taken 40 per cent. in bulk and in value. The total imports of timber to Great Britain from various countries in 1900 was £25,084,000, and Russia's share in this was only £6,203,000; but in 1913 the United Kingdom imported timber to the value of £29,998,000, of which Russia supplied £13,622,000.

These statistics show that Russia is gradually taking the place of other countries on the British markets. After the war the position will be still further improved. The Northern ports, which were the only ones open during the war, are now better equipped, and railway connections with the main lines have been greatly strengthened. As a result, Russia will free herself from German influence.

In this connection Germany's *rôle* is striking. She established extensive industries at the mouths of the rivers Niemen and Vistula for the working of Russian crude timber, from which she received all the profit, and exported the high-priced manufactured article to all countries in Europe. By means of high Customs rates on prepared timber Germany compelled Russia to supply principally raw material.

Germany cannot dispense with Russian timber, which in 1913 contributed 50 per cent. of Germany's total timber imported. After the war Germany's requirements will be greater than ever before, particularly as the Galician forests of Austria-Hungary, which previously supplied Germany with some 30 per cent. of her timber requirements, have, to a great extent, been

destroyed. Russia's future policy will be directed to the construction of extensive enterprises in North Russia, the discontinuance of the export of timber surrogates to Germany for the production of wood pulp required in the manufacture of paper, and the conversion of this in Russia, for the demand of the world's market for wood pulp is growing at a rapid rate, Great Britain alone having imported over £9,000,000 in 1913; while Germany, thanks to occupy a dominating position in Europe in respect to sawn or prepared timber, and in time, by gradually going over to the manufacture of wood pulp and of paper, she may monopolise this branch of industry.

The Russian forests have in front of them a truly inestimable prospect for the timber industry, which in the next few years will become the hub of the political economy of the Russian Government.

Russia, was able to export wood pulp to Great Britain to a value of £3,500,000 after covering her own requirements.

British capital has not been used up to the present in the Russian timber industry; it has been directed to the Scandinavian countries, where it has established a fairly important industry, which is now obliged to fall back on Russian crude material; while Russia, the owner of the crude material, in the past has imported every year £3,000,000 to £4,000,000 worth of paper. After the war Russia can immediately

New Trade Routes.

Until quite lately Russia has done little or nothing towards the promotion of railways or utilisation of waterways for the exploitation of her great timber resources of the North. Felling rights on forest lands, which in the North practically belong entirely to the State, were only granted on short-term leases of four years, which made it impossible for the lessee to risk capital expenditure in roads, forest railways, dams, sluices, etc., as this expenditure could not be returned in this short period. For

these reasons the capital invested to-day in this very important branch of Russian industry is insignificant.

In the whole of Northern Russia there has hitherto been only one railroad that connected the railway systems of the Empire with the Polar sea (Vologda-Archangel), and this railroad leads into the port of Archangel, which is icebound in winter. Being cut off from Western Europe owing to the closing of the Dardanelles and the Baltic, Russia hurriedly commenced the construction of a railway from Petrozavodsk, near Petrograd, to the new port of Alexandrovsk, in the Mourman Gulf, which will be open for traffic in January next. The new port is open to shipping all the year round, is accessible to the largest ocean-going ships, is the nearest to the United Kingdom, lies near an open sea-way, and is nowhere shut in as her other ports are. This new railway route, with its open-sea passage, opens a new page in the history of the exploitation of the North of Russia and Siberia on the one hand and the connection between Russia and England on the other. The sea route will be shorter to the United Kingdom by about a day than from the Baltic ports. The new port will divert a huge traffic which, when the Finnish and Baltic ports were icebound, was carried in pre-war times by railway to Germany, mainly to the great collecting and distributing port of Hamburg; so that consignments of grain, agricultural produce, eggs, etc., which found their way to the United Kingdom through Hamburg, and to a small extent through Denmark, will be able to come direct, and will thus do away with the middleman's profit and the grip Germany was getting over Russian trade.

In addition to this railway, a scheme for the construction of a new line linking up the new Northern line (near the Sarotsk Bay on the White Sea) with Perm is under consideration. This railway will still further develop the North and bring the products of Siberia and the Urals much nearer to the markets of the world, especially to Great Britain.

In order to realise the importance of these new northern railways in the exploitation of the northern forests, it is only necessary to state that if the exploitation of the forests of the Archangel and Vologda Governments which will be opened up by these railways were brought into line with the average of the rest of European Russia, and the income was taken on the very lowest normal Russian rate of 3*s.* 6*d.* per acre, the Government Treasury would receive from the exploitation of the forests of these two Governments alone a net yearly revenue of £26,000,000, instead of only £516,681, which was all that the Government realised in 1913.

The Question of Imports.

In dealing with the financial position I have sought to bring out how vital it will be for the Empire to restore the exchange value of the rouble and re-establish the financial position of Russia amongst the nations of the world. The inherent resources of the country have so far scarcely been touched. The future growth of exports will be colossal—of snowball nature—especially, as pointed out, in the direction of agricultural and forestal products. But it is not alone in exports that Russia in the future can improve her position. She now imports to a considerable extent articles that she can produce herself, as reference to the statement of imports of 1913 will show:—

	£	£
Plants and seeds	2,913,500	
Fresh fruit, lemons, nuts, and plums	2,477,900	
Fish and oysters	3,820,200	
Tallow, animal fats, and beeswax	2,025,300	
Prepared leather and manufactures of leather	2,789,600	
Carpentry and fretwork	667,900	
Boot blacking	600,000	
Vegetable oils	575,600	
Resin and pitch	494,700	
Wood pulp and cellulose	219,600	
Higher class paper	1,100,000	
Toys	992,400	
Raw and manufactured silk	4,247,000	
Thread and yarn	3,006,900	
Woollen goods	4,582,100	
Lace	765,500	
Wines	2,058,800	
Furs and pelts	1,632,400	
Paraffinum and vaseline	239,500	
Live stock	1,761,500	
Bark tanning for tanning	771,900	
Flax, hemp, and articles thereof	708,400	
		37,910,700
Bar iron, steel implements, tools, nails, constructional material, drain pipes, glass physical apparatus, hardware, etc.	15,279,400	

	£	£
Chemical goods, pharmaceutical goods, spices	4,749,700	
Coal and coke	8,777,000	
Machinery	12,944,700	
Agricultural machinery	3,984,500	
Raw cotton	11,404,100	
Other goods	28,999,900	
		86,139,300
		£124,050,000

An adverse trade balance of some £60,000,000 has been calculated. Let us examine how a part of this can be met if economies are effected. Amongst the imports we find that fresh fruit accounted for £2,477,900, fish and oysters £3,820,200, tallow and beeswax £2,025,300, leather in finished form £2,789,600. It is absurd that these edibles and leather should go to Russia, which produces the finest fruit in great quantity, and the rivers and seas of which abound with fish as do those of no other country in the world.

There is also a large import of fretwork, flax and yarn, furs, live-stock, plants and seeds, etc., which aggregate some £38,000,000, all of which articles are produced in the country in large quantity and sold locally very cheaply, but owing to want of means of communication and organisation do not reach the market.

Of other items given above, it need hardly be mentioned that the import of coal and coke to the value of £9,000,000 is an anomaly, but was due to the intensive development of industries in 1913. Raw cotton for a number of years has been imported into the country at the rate of 200,000 tons a year, to the value of some £11,400,000. If the country would reduce the import of these articles by only 50 per cent. this alone would cover half the deficit which we have calculated.

It will be abundantly evident from the analysis of the figures of imports that a very great decrease in the sums paid abroad is bound to take place, and almost immediately. These decreases in imports, together with the advantageous position of the exports which have been here described, make it certain that the balance of trade can be easily adjusted after the war to cover any deficit in the financial balance, and even to leave a large surplus on the right side.

As to the future, there can be no question that the sound intrinsic position of the trade balance will make it possible for the Russian Empire to meet any possible international financial obligations which she may have incurred through the war many times over.

Railway Construction.

The Government and people of Russia realise that, whatever the financial position after the war, further loans will have to be floated to carry out a policy of intensive development, and that this increased capital expenditure for productive purposes will increase the deficits; but they realise also that by this means only will they be able to create conditions which will make it possible to exploit the boundless wealth of the country, and thus quickly liquidate the debts caused by the war. The most important means towards this end is the development of railways. It is the absence of adequate means of communication which has prevented Russia from being the richest and most prosperous country in the world to-day. In this respect it is very significant of the strong feeling of the country that, although the nation is at war, provision of £30,000,000 is made in the Budget for 1917 for expenditure on construction of new railways. At January 1st, 1915, the length of railways of general importance was about 50,000 miles, of which only 6,744 miles were in Siberia. The United States had in 1913 a railway system of over 266,000 miles; the population of the United States is, roughly, 97,420,000, and its area is 2,973,000 square miles. In other words, the United States, with a population, roughly, of only one-half, and an area of only one-third of the Russian Empire, has more than five times the mileage of railways.

Even in European Russia the peasant has to transport his agricultural produce an average distance of thirty miles to the railway over bad roads, often, in fact, mere tracks, and he can, on the average, do the journey only twice a week, under the best conditions of weather. At certain seasons the transport is impossible. It will be evident what an enormous addition to the productive power of the country it would make if the peasant had to travel an average of, say, only eight miles, as in the Transatlantic Republic, and could, therefore, do his work in one day instead of one week. Apart from this, horse-transport necessitates additional capital expenditure in equipment, and it is officially estimated that it costs the Russian peasant on an average not less than 28s. per ton to carry his produce to the railway. Without continual connection with the market it is difficult to imagine a systematic industrial system. The urgent need of an extended railway system may be seen from the intensive working of the existing system, which in 1912 carried on average 8,000,000 tons

per mile of railway. In the United States it averages only 5,000,000 tons per mile; in France and Hungary 3,200,000. Such intensive work is owing to the fact that the growth of the system has always been behind the general development of the country and its transport requirements.

The extension of the railway system is considered by the Government and public opinion to be a question which must not be delayed. It is officially estimated that at least 4,000 miles must alone be constructed every year to cover the average 8 per cent. yearly growth of traffic on the railway systems. And so strong and unanimous is the feeling that the Government has already approved and authorised a large programme entailing the immediate construction of some 30,000 miles of new railways of national importance, and the construction of many more thousands of miles is under consideration. As an indication of the strength of public opinion in this matter it may be mentioned that an issue of railway bonds to the value of £35,000,000 made in Russia in October last was subscribed for by the public four times over.

Iron and Steel.

With the above-mentioned railway construction in view, also repairs and renewals in all directions consequent on the destruction caused by war, there will come an enormous demand for iron and steel; and after the war such demand will be far beyond the present productive capacity of the country. Russia, however, has suffered so much during the war from the lack of railways that at whatever cost this shortage will be made good. For a time, therefore, and although this means the export of gold and payments abroad, rails, rolling stock, machinery, and constructional iron will be imported to meet demands. Meanwhile new railways will open those almost inexhaustible deposits of iron ore and coal at present known, but inaccessible, and which are lying unexplored. The large requirements creating high prices will naturally continue still further to stimulate industry as it has done during the war. With the return of the millions of workers at present under arms the pace will be quickened, and the time is not distant when Russia will take her place among the great producers of iron and steel of the world.

Russia's production of pig iron for 1913 was only 4,500,000 tons, that of the United States some 30½ million tons. This comparison is a very conservative criterion of the prospective requirements which the present and future iron and coal industries of Russia have to meet, and there can be little doubt that we have beginning in Russia to-day a repetition of the intense development of these industries which has been going on for the last thirty-five years in the United States. There is room here for many years to come for British enterprise and British capital, and to those Englishmen who take a hand the Russian Government and the Russian people will offer a very hearty welcome, for it is recognised that with British aid the process will be greatly quickened.

Britain's Help in World's Railway Construction.

It may be of interest here to note that Great Britain has always played a leading part in the financial development of railway systems of countries supplying her with foodstuffs and raw material. British capital was freely invested in such undertakings. From 1907 to 1913 alone the total railway issues in the United Kingdom reached the enormous figure of £396,735,950, allocated as follows:—

	£
India	19,655,125
The Colonies	118,623,776
Foreign Countries . .	258,457,049

During this period, however, British capital almost entirely ignored Russian railways, notwithstanding that Russia had yearly been growing in importance as a supplier of food. The interests of Great Britain strongly demand new and increasing outside sources of supply of food and raw material. With the increase of its population and the development of its industries the United States, which up to now has supplied about 50 per cent. of British requirements, although increasing its production yearly, has to diminish its surplus exports of wheat and agricultural products to this country.

Great Britain, in the interests of supplying her population with foodstuffs and her factories with material, has in the past invested £1,521,041,000 in issues for construction of railways outside the country. A great deal of this money has been invested for this purpose in countries like Argentina, Brazil, Chile, Cuba, Mexico, Peru, Turkey, etc. Surely, then, railway issues, the interest on which is guaranteed by the Russian Empire, with its boundless wealth and teeming population, with all its resources for rapid and successful economic development, and being geographically better placed for our markets than

any other food-producing country, present a safe and profitable investment.

Mining and Metallurgy.

The mineral wealth of the Russian Empire is recognised to-day by competent authorities as offering enormous possibilities. The Caucasus, the Urals, Central Asia, and Siberia, all contain vast areas of highly-mineralised ground of great promise asking for exploration and development. Some of the deposits of gold, silver, lead, zinc, and copper ores which have been opened up and developed are of world-wide importance and extraordinary value; iron, manganese, magnesite, and all materials necessary for smelting abound; vast salt deposits exist, with coal and sulphur in close proximity for alkali and fertiliser industries; extensive deposits of asbestos and graphite, and basins of the finest coal, petroleum, and oil shales are well known. The North Urals produce 95 per cent. of the world's platinum; there are gold placers and deposits of tin, wolfram, vanadium, and other of the rarer metals and precious stones. In short, there is hardly a mineral or metal known in the mining world to-day that the great Eastern Empire cannot produce; and yet these untold riches are lying idle and almost untouched; and, sadder still, instead of being able to supply her own industries and those of the world, there are hardly any of these metals and minerals mentioned, with the exception of petroleum, manganese, salt, and platinum, which Russia, the owner of this vast wealth, has not to import for her requirements.

Why is this? There is but one answer—want of means of communication, want of railways and means of transport. Metals and minerals are more often than not found in places remote hundreds and sometimes many hundreds of miles from the one existing trunk railway through Siberia. In a country like the United States, which is well traversed by railways, the miner has only to find, prospect, and develop large reserves of ore in his mine—the railway company will immediately lay a branch to his mine and bring him workmen, machinery, fuel, timber, provisions; the mine owner has only to extract and sell the ore raised from his mine, the Customs smelter will take care of it. The capital necessary for the mine itself is comparatively small, and this makes it possible to work small as well as large mines.

The new railways which are projected and authorised to traverse different parts of Siberia will provide the miner with the means to open up in a short time many mining districts containing large as well as small mineral deposits, and will give a great stimulus to mining and metallurgical enterprise in the country.

Siberia is a country with a good climate, well timbered, with rich virgin lands ready for cultivation, and, like all other new countries which are blessed with mineral wealth, its colonisation will be all the more rapid if the miner, the pioneer of industry, is given the possibility to open its dormant mineral riches. The settlers will follow the miners as they did in the United States, South Africa, and Australia.

The Russian Empire owes a great deal in the development of its copper, gold, lead, and zinc to British mining capital and enterprise: 50 per cent. of the copper and over 30 per cent. of the gold in Russia is produced by Anglo-Russian companies. The impulse given to the development of the petroleum industry was largely due to British capital and energy, while it was a British enterprise which introduced modern mining and metallurgical methods and processes, which permitted the working of properties that had long remained fallow, or had been abandoned in the Urals and Altai regions. The first and only large metallurgical works producing coke, zinc, and lead in Siberia are the outcome of British enterprise.

Of the more important industrial metals, the production of copper in Russia before the war was only 75 per cent. of the consumption, and of its requirements of lead and zinc 96 per cent. and 75 per cent. respectively have to be imported. The United States produced in 1913 557,400 tons of copper, and for 1916 it will probably, under present stimulus, output some 800,000 tons, whereas the Russian production of copper for 1913 was only 33,250 tons. After the war, with an intensive programme of railway construction, the expansion of the iron and steel trade, and the many manufacturing and chemical industries which have been started during the war, the requirements in these metals will increase more and more. Something has already been done in showing the possibilities and exploiting a few of the mineral deposits in the Russian Empire, but the field is so great that what has been done so far is an infinitesimal part of the possible whole.

Take the case of a single metal. In the matter of copper production Russia is to-day in about the position of the United States in 1881. The United States produced only 32,000 tons in that year, or just about what Russia did in 1913. The parallelism extends further: the Russian Empire to-day has, just as that country then

had, great copper districts lying undeveloped—how great I cannot pretend to guess. But it does not follow that it will take thirty-five years for Russia to come into her own in the matter of this metal. The way has been found, the methods of mining and treatment have been elaborated, and have become the commonplaces of the modern mining engineer, so that, in the future, years can be expected to show the advance of decades in the past. I venture to say that in 1881 a copper ore containing 4 per cent. or 5 per cent. was scarcely profitable. To-day perhaps half the production of the States comes from ores of less than half that value. Further, long-sighted business men in the United States are tô-day looking forward to the time when even their enormous deposits will show exhaustion, and are casting about for new sources of supply; it is known that their eyes are turning to Russia as the only unexploited civilised country where new sources can be found.

What is true of copper is also true of lead, zinc, and other metals.

A personal experience of twenty years' mining and metallurgical work in the Caucasus, the Urals, and Siberia, in the management and control of Anglo-Russian undertakings employing some 40,000 men, enables me to say that in this department of industrial activity British enterprise and capital are welcomed and fostered by the Government. The nation recognises that British technical knowledge, practical experience, and the capital invested in this direction is an educating and civilising influence, opens up new country and new industries, gives work and bread to the people, keeps money in the country, and for these reasons the Russian Government has never grudged the earning of large profits, recognising that without this result the capital necessary for the development of the country will not come in.

Russia's Past Share in British Investments Abroad.

Great Britain, who, similarly to France, had before the war ceded to Germany front rank in the industrial world, was undergoing an evolution in the direction of financial capitalisation. Owing to their great accumulation of wealth these two countries had become the world's bankers, and it was as necessary for them to place capital in poorer countries as it is for Russia to-day to borrow capital.

If we examine the direction of British capital to the principal countries of destination it will be found that during the period of seven years from 1907 to 1913, according to the *Statist* of February 14th, 1914, the total invested was £1,127,000,000, divided up as follows:—

	£
India and Colonies	481,529,927
Argentine	118,339,585
Brazil	88,227,036
Chili	27,563,340
Cuba	14,563,385
Mexico	33,822,322
Peru	6,988,691
United States	164,201,850
Rest of America	11,128,188
Austria	6,247,896
Bulgaria	3,819,499
Denmark	6,844,600
Egypt	6,427,577
Finland	3,441,450
Greece	3,301,644
Hungary	2,077,240
Norway	4,833,250
Roumania	4,429,875
Russia	46,214,906
Siberia	994,993
Sweden	4,556,000
Turkey	4,745,869
Other European Countries	9,280,176
China	27,805,737
Dutch Colonies	12,236,971
Japan	22,447,240
Persia	2,706,250
Philippines	2,238,283
Siam	1,102,500
Rest of Asia	175,000
Africa	2,702,603
Others	2,436,146
Total	£1,127,431,129

Chili and Cuba combined received almost as much as Russia, and Brazil almost twice as much. From now onwards the distribution of capital will doubtless be greatly modified.

The investment of capital in Russia is of advantage not only in the interests of capital alone, but it is also vital in the politico-economic interests of Great Britain that Russia should be strong. By helping the economic development of Russia, Great Britain is at the same time working in her own vital interests; the raising of Russian industry supported by a population of 200 millions represents such an enormous power that it signalises the political and economical weakening of Germany. Any weakening of Russia is at the same time a strengthening of Germany. If Russia were militarily crushed and economically bound, the master of Europe would be

Germany; and the fate of France, and later possibly even of Great Britain, would be sealed. After the war. Germany will make strenuous efforts to regain her commercial supremacy and political influence in Russia, and the war will have been fought in vain if this country does not put out every effort to develop close commercial relations, and thus establish the soundest basis for the economic and political alliance which is mutually necessary between the two countries.

That Russia can at no distant date fully liquidate her debts has already been shown; the capital sums are guaranteed by the immeasurable, if undeveloped, wealth of the country; this wealth only waits for machinery to become tangible. Great Britain is interested in this from all points of view, as the political and economical interests of both Empires are closely allied. By strengthening the Eastern Empire Great Britain is forging arms for her own defence.

Before the war the spread of civilisation in Russia was steadily making her ready for economic expansion. The intellectual development of the masses was going on rapidly. The State expenditure in 1897 on education was only £4,061,611; but this expenditure was yearly increasing, until the State Budget for 1917 provides the Ministry of Education with £21,421,202.

If the war had not broken out the country would have solved the problems as they arose. The war has forced events, as wars have done more than once in the life of Russia. Serfdom was abolished after the last Crimean campaign, and the State Duma came into being after the Russo-Japanese war.

A world's tragedy cannot be passed through without its leaving a deep impression on the psychology of the nations taking part in it, and the Russian Empire during its long history has never conducted a war in which the people have entered with such discernment. This discernment does not apply so much to the international relations as to the internal events in the country itself. The army is no longer made up of specialists, but of the manhood of the whole nation under arms. The trenches of Poland and Galicia, the mountains of the Caucasus, the training grounds at home, the workshops of the country, have seen a process of education going on for the past two years that no amount of schooling could ever give. Citizens of a mighty Empire thousands of miles apart, knowing heretofore little of each other or of the districts they lived in were brought together. Simple peasants from the plains of Russia and Siberia, hillmen from the Caucasus, Altai, and Turkestan, shoulder to shoulder with men from the towns, men of education and refinement, all living and suffering together, understanding and educating each other for those years—a real brotherhood of man, their patriotism making them conscious of their destiny and their duty to their native land. Can it be wondered at that the army and the nation have become impregnated with the conviction that the vital interests of their country, for love of which they have been fighting and giving their lives, demand, among others, certain reforms, which may be stated in a brief formula? The formula is to create by every possible means, and in the shortest possible time, favourable conditions for the rapid development of all branches of agricultural and industrial activity, for the good of the people and the strength of the Empire.

DISCUSSION.

The Chairman (the Right Hon. Lord Carnock, G.C.B., G.C.M.G., G.C.V.O., K.C.I.E.) said he was sure that those present would authorise him to convey to Mr. Urquhart their best thanks for his most interesting and instructive paper. In a small compass he had dealt clearly with some most important questions, and he had laid before them a statement which merited the most careful study, one which he hoped would stimulate British capitalists and business men in extending and developing their operations in Russia. He most sincerely trusted, and he was sure it was the hope of all, that the commercial and industrial relations between the two countries would develop and prosper, and not only would such intercourse be of incalculable material benefit to both peoples, but it would assist in strengthening those ties which had already been established on the battlefields of Europe by sacrifices made in the furtherance of a common cause. Any measures which would promote sympathy between the two countries and enlarge their knowledge of each other should be warmly encouraged, and he could conceive no better means of achieving that result than a closer commercial and industrial relationship. This war had greatly embarrassed the export trade of Russia, which was so important a factor, and it was certainly highly to be desired that the railway to the new port of Alexandrovsk should be opened to traffic as soon as possible. The observations of Mr. Urquhart with regard to the great financial position, to the great prospects in Siberia, and to the agricultural, forest and mineral wealth, deserved the most careful attention. It stirred the imagination to listen to a description of the vast and varied resources which only await capital and better means of communication to be

developed to an extent hitherto undreamed of. He hoped that in assisting the furtherance of the development British capital would not be lacking. It was now that preparatory steps should be taken to that end. If we waited until the indeterminate date of the termination of the war others would probably step in and forestall us. We should take our steps at once. The closing paragraph of Mr. Urquhart's paper enunciated in eloquent terms great truths, and he hoped they would be laid to heart. He endorsed every word that had been said. The distrust, apprehension and suspicion between Great Britain and Russia had been laid to rest for ever, and it was for all well-wishers and friends of Russia to do all that lay in their power to cement the bonds between the two countries.

Lord Weardale expressed his warm acknowledgment for an admirable *exposé* of the potentialities of the Russian Empire. All who had been acquainted for a long period, as he had, with many parts of Russia were conscious of the great possibilities which lay dormant, unfortunately, in the circumstances under which Russia then existed. In addition to those potentialities it was all-important that the soul and the spirit of the Russian people should be aroused. That was what those who admired and respected them perceived, and most of them recognised that this awful war, which none could think of without horror, would bring to some lands, and possibly to no country so much as to Russia, the prospect of an awakening to the possibilities of a great future, and, he hoped, the emancipation of the intellect of the manhood and the womanhood of Russia in a sense which up till now they had not perhaps had the opportunity of foreseeing.

Dr. John Pollen, C.I.E., added a few words of appreciation to those already spoken. It was very gratifying to hear a true description of the real state of Russia, and to hear of the great possibilities which had been so long concealed. More than a quarter of a century ago he visited Russia, and discovered nearly all the facts that had been so ably put forward in the paper. Why had these facts been concealed from the British people? In old times there were prophets in the land. The prophets of the present day were represented by the press of England; but, alas! the press of England allowed itself to be hoodwinked by the enemy and misrepresented Russia on all occasions and in all places. It was only now that the press had opened its eyes to the true facts. He was afraid that the prophets of the day were so intent on their own profits that they neglected the true prophets. The press held out the bugbear that Russia wanted India. Having heard of the magnificent resources Russia herself possessed, was it likely that she would care to hamper herself with the difficulties the English people experienced in administering India? No. He hoped the facts given in the paper would be published throughout the length and breadth of the land.

Sir Donald Mackenzie Wallace, K.C.I.E., K.C.V.O., said the paper gave a mass of valuable statistical information brought up to date. This was a thing that must be drummed into the British public. We were a thick-headed race—very thick-headed—and when we took a preconceived notion on anything it was excessively difficult to get it out of our heads. Of all countries in Europe, certainly the greatest number of preconceived notions which had assembled in the British mind was about Russia. He well remembered fifty years ago, when the anti-Russian fever was at its height, and he was regarded as a horrible Russophil; but he was happy to say that since then we had made enormous progress. This progress was not in mere sentiment, but in solid knowledge, which should produce a very great effect in the future, whether on account only of our love for a faithful ally, or even from lower motives, from that desire for national self-enrichment, which some people described as the mainspring of our policy. It was quite certain that we could not only bind to ourselves that ally who was doing such splendid work in the East of Europe, but we could at the same time have a moderate remuneration for our effort.

Sir John Jardine, K.C.I.E., M.P., remarked how extremely well the excellent statement of the case put by Mr. Urquhart coincided with the movement going on in the City of London and in the City of Glasgow to increase the possibilities of trade with Russia, now and when the war ended. He need not allude to the fact that a Russo-British Chamber of Commerce had recently been started here, and that a Russian society had been started in Glasgow. As regards the chief matters upon which capital could be expended, Mr. Urquhart had pointed out the enormous value of the agricultural products of the country, and one might say from that that money should be sent from here to develop those great fields. On the other hand, the want of fertilisers had been pointed out, so that the return would not be so rapid, and he should think, from Indian experience, that Great Britain would not gain much by undertaking the direct loaning of money to the cultivators of the soil. They might do something in the way of mining the fertilisers wherever they might be. The author seemed to be fixed on the right thing, and one that would appeal to most capitalists in Scotland and England, in developing railways. It was felt long ago in our own thickly populated country that we should not have nearly enough to live on unless we went further afield, and British capital went out to Canada and the United States in great quantity. Then it was found that the best use to put it to, in order to reach the fields where wheat might be

grown, was to build railways, and that had been carried out ever since. A similar course of action would coincide with the development of the great wealth of Russia. Mr. Urquhart himself had played a great part in the development of Russia in dealing with copper and the precious metals, and he believed they had discovered nickel lately, and shale oil in the Urals and Siberia. Wherever there were railways, and in some places where there were not, Mr. Urquhart seemed to have been; from the Caucasus to the new port in the Arctic regions which was now being built and would be working before long. It was now quite clear that the more railways there were the nearer we got to the fertile lands, and the nearer we got to the mines. In this matter we should go on the experience of Canada, the Argentine, and India, where there was a great system of railways, carefully considered with forethought years ahead as to how much development should be done. That problem was being considered by the Russian Government now, and he could see no reasons, given a firm government to begin with, and a progressive government next, why a much larger quantity of British capital should not go to Russia to found new railways. The paper had shown the possibilities of mining to be boundless, the very kind of thing in which British enterprise had long been successful. It was known that the enormous number of railways in Germany had not only increased the demand for iron and steel enormously in proportion to the mileage, as in the United States, but it had also given Germany a commanding influence in the markets of Europe. Germany had lately been increasing her trade in the markets of Europe by using that land transport, although at the same time we had outdistanced her in using our sea-going power to take our goods to the other markets of the world. If Russia were nearer to the other countries, and especially with railways, it must increase her trade enormously. With more railways would come more hotels, and with hotels would disappear many of the inconveniences experienced now when travelling in Russia. The paper was one well worthy of the Royal Society of Arts. As the development of art went with the development of commerce in our own very practical country, he hoped the paper would soon be in the hands of those captains of industry, those merchant princes who were to be found in the City of London, in Glasgow, and in the other great trading centres.

The vote of thanks was then put to the meeting and carried unanimously.

Mr. Urquhart replying, said he was deeply sensible of the shortcomings of his attempt to deal with a subject of such magnitude within the short time at his disposal. Necessarily, he had been compelled to deal with it more or less on broad general lines; but he hoped, through the medium of the Society, the paper would be of use to those who might be induced perhaps to study the subject still further, to the mutual advantage of the two countries.

The meeting then terminated.

OBITUARY.

Peter Brusey Cow.—Mr. Peter B. Cow, whose death took place after a long illness on August 27th, was a member of the Society of forty-seven years' standing, having been elected in 1869. He was born in 1847, and after being educated privately he entered the rubber works of Messrs. Cow & Co., in Factory Square, Streatham. He took an intense interest in the welfare of his employees, all of whom he knew personally, and until recent years it was a rare thing for any of his workers to leave for other employment.

Mr. Cow was a generous supporter of the Church, to which he was devoted, and his benefactions, public and private, were very numerous.

David Howard, D.L., F.I.C., F.C.S.—Mr. David Howard died suddenly on the 14th inst. as he was travelling from his residence at Buckhurst Hill to his offices at Ilford. He was the son of Robert Howard, and grandson of Luke Howard, F.R.S., who founded the well-known firm of manufacturing chemists, now styled Messrs. Howards & Sons, Ltd.

David Howard entered his father's firm (then Howard & Kent) in 1857, and soon afterwards became a pupil of Hofmann at the Royal College of Chemistry in Oxford Street. Throughout his life he took the deepest interest in the development of chemical education and research. He served on the Council of the Chemical Society, and was a Vice-President on several occasions. He was one of the founders of the Institute of Chemistry, a member of the first Council, and President for the period 1903-6. He was an original member of the Society of Chemical Industry, of which he was President in 1886-7, and he was for some years Chairman of the Chemical Section of the London Chamber of Commerce.

Mr. Howard became a member of the Royal Society of Arts in 1879. He presided at a meeting in 1884 when a paper on "The Manufacture of Gas from Limed Coal" was read by Mr. J. Alfred Wanklyn, and he took part in discussions on several occasions.

NOTES ON BOOKS.

The Tale of the Armament of Igor, A.D. 1185. Edited and translated by Leonard A. Magnus, LL.B. Oxford University Press. 1915.

The Russian language and Russian literature are receiving a great deal more attention than they did three years ago. English people are

learning the former, and thereby qualifying themselves for the study of the latter. Hitherto the few Russian authors who were known in this country were known only in translations, sometimes in double translations, an English version adapted from a French one. It is true that the difficulties, or presumed difficulties, of their vernacular compelled Russians to study other languages, and the result has been that they share with the Dutch the reputation of being the best linguists in the world.

The mediæval epic which Mr. Magnus is the first to introduce to English readers has a curious history. In 1795 Count Musin-Puskin, a well-known archæologist, bought from a monastery a volume of manuscripts, amongst which was the original of the "Slovo." It was printed and published in 1800, but the manuscript and most of the prints perished in 1812 in the fire of Moscow. The printed book thus became the original, and was so regarded till 1864, when a second copy of the original manuscript was found among the archives of Catherine II. with notes and a translation into modern Russian which was apparently made by Musin-Puskin for the Empress.

The poem seems at first to have been regarded in some quarters much as the contemporarily published "Ossian" was regarded in London, but such doubts were soon settled and its authenticity is accepted as beyond dispute.

Its author is unknown, but its date is fixed by certain references as 1185 or 1186. Its subject is an expedition (by Prince Igor, one of Rurik's descendants in the fifth generation and a kinsman of the contemporary Grand Princes of Kiev) in one of the innumerable wars which were carried on in Russia's essentially feudal period. As it appears to be the only complete poem of its own time and character amongst numerous fragments, it may doubtless be regarded as being, in Mr. Magnus's words, "one of the treasures of Russian mediæval literature."

It would be difficult to speak too highly of the completeness with which the work of editing the poem has been carried out, or of the scholarly fashion in which it has been executed. Besides the text and its translation with copious notes, there is a long introduction giving an account of the primitive geography of Russia and a summary of its history up to the Mongol Conquest (in the thirteenth century), with separate essays on the construction, composition, language and other characteristics of the poem.

Beautiful Buildings in France and Belgium. London: T. Fisher Unwin, Ltd. 12*s.* 6*d.* net.

This is a book to delight the hearts of all lovers of Gothic architecture. It consists of reproductions in colour and monochrome from rare old prints and drawings, by and after Prout, Boys, Coney, W. Callow, David Roberts, C. Wild and others, and each illustration is accompanied by a brief but adequate note by Mr. C. Harrison Townsend, F.R.I.B.A. Many of the pictures have unfortunately now acquired an added interest because the subjects which they represent exist no longer. The beautiful Cloth Hall of Ypres, of which there is a charming sketch by J. Coney, is now levelled with the ground, and only one corner of its fine tower remains standing. This was the finest of the Trade Halls of Belgium as well as the earliest to be erected, and "the restoration of the whole building had been barely completed when the destroyers robbed the world for ever of one of its fine and gracious works of art."

Perhaps the finest illustration in the book is G. Simonau's picture of the west front of Rheims Cathedral, which is almost photographic in its extraordinary care and detail. It seems scarcely conceivable that even the most barbarous of enemies should have vented his fury on a building at once so beautiful, so majestic, so delicate, and so wholly void of offence. The Cathedral has been subjected to the cruellest bombardment, till it is now but a shell-torn ruin. It is well that we have Simonau's drawing to remind us of the glory that was Rheims.

For the whole get-up of the book one can have nothing but praise. The type is admirably clear and the setting out of the pages, with their red headings and initials, is most satisfactory. Nor can any fault be found with the reproduction of the drawings, especially those in colour. For instance, in the frontispiece, which reproduces a painting by T. S. Boys of the Hôtel de Ville at Arras, the tints are most delicate and charming and another attractive page is filled by C. Wild's drawing of the south entrance of Rouen Cathedral.

GENERAL NOTES.

Distress in Belgium.—An urgent appeal is issued by the National Committee for Relief in Belgium on behalf of the Belgian children. A careful investigation has been conducted by Dr. William Palmer Lucas, Head of the Department of Children's Diseases in the Medical College, University of California; he has spent some months in the territory occupied by the Germans, and he finds that in 65 per cent. of the population the effects of two years' captivity on short rations has now become painfully apparent. The vitality and resistance to disease have been lowered, and this is due mainly to under-feeding. The result is that tuberculosis has increased by 100 per cent. Every sanatorium in Belgium is now crowded, the waiting lists of all the sanatoria have increased, and the waiting cases are now more acute than formerly. As it is impossible to isolate these acute cases, they are rapidly

spreading the disease. The only means of fighting this peril is to secure for the children a better supply of food. Contributions should be sent to A. Shirley Benn, Esq., M.P., Hon. Treasurer, National Committee for Relief in Belgium, Trafalgar Buildings, Trafalgar Square, London, W.C.

MR. PENNELL'S DRAWINGS OF MUNITION WORKS. —Mr. Joseph Pennell has been engaged for several months in making a series of remarkably fine drawings of munition works in various parts of the country. These will be shown, by consent of the Ministry of Munitions and on the invitation of the Corporation of the City of London, at the Guildhall Art Gallery. The exhibition will be opened on December 1st by the Lord Mayor, and the Right Hon. E. S. Montagu, Minister of Munitions, will speak on the occasion.

PAPER MATERIALS.—The growing scarcity of materials for the manufacture of paper has led the Bureau of Science of the Philippine Islands to make public some important data concerning the supply of such materials in the islands. For several years the bureau has been investigating the suitability of bamboo, cogon grass, abaca, and various palm fibres for paper pulp. The facts collected are regarded as evidence that an industry of great economic value could be developed. Careful surveys of some of the bamboo fields have been made. Data regarding the cost of the raw material, the quantity of bamboo available, and the cost of manufacture of the pulp show that the bamboo soda-pulp industry can be developed for a possible export trade in direct competition with chemical wood pulp at present quotations. Other countries already have utilised the information obtained from this work, which ultimately may be the means of starting the paper industry in the Philippines.

CHINESE TELEGRAPHS. — The *London and China Telegraph* draws attention to the great improvement that has recently been made in the service of the Chinese Telegraph Administration. New territory has been reached and new offices opened in fields already covered. To ensure speed in the transmission of telegrams the Wheatstone automatic system has been adopted on all trunk lines. In order further to accelerate the transmission of telegrams, three years ago the Administration began the installation of the automatic duplex system on its more important lines, the first installation being made on the Pekin-Tientsin line. In May and June this system was put into use between Pekin and Hankow and Hankow and Shanghai. The average working speed attained on the 85-mile Pekin-Tientsin line is 110 words a minute, while seventy words a minute is the average speed attained on the 750-mile Pekin-Hankow line and the 720-mile Hankow-Shanghai line. Taking into consideration the interruptions caused by climatic conditions and the great length of some lines, the speed of transmission compares favourably with that of European and American lines under similar conditions. It is the intention of the Administration gradually to extend the duplex system, and no doubt in the near future it will have been established on all important trunk lines in China, thereby doubling the capacity and reducing the delays to which the traffic would otherwise be subject.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. :—

NOVEMBER 29.—DUGALD CLERK, D.Sc., F.R.S., "The Internal-Combustion Engine." The HON. SIR CHARLES A. PARSONS, K.C.B., LL.D., D.Sc., F.R.S., will preside.

DECEMBER 6. — C. M. WHITTAKER, B.Sc., "The Coal-Tar Colour Industry." SIR WILLIAM A. TILDEN, D.Sc., LL.D., F.R.S., will preside.

DECEMBER 13. — H. WILSON FOX, "The Development of Imperial Resources."

DECEMBER 20 (at 4 p.m.).—A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m. :—

DECEMBER 14. — JOHN AITON TODD, B.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it." The RIGHT HON. LORD EMMOTT, P.C., G.C.M.G., will preside.

Dates to be hereafter announced :—

LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

OCTAVIUS C. BEALE, "British Arts and Crafts after the War."

Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel."

Surgeon-General Sir C. Pardey Lukis, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

Joseph Pennell, "The Artistic Aspects of War Work."

Gabriel Gordon Cleather, "The Drum."

Francis A. Hocking, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

Robert Fortescue Fox, M.D., "British and Foreign Spas."

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

January 18, February 15, March 15, April 19, May 17.

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

January 30, February 27, March 27, May 1.

Howard Lectures.

Monday afternoons, at 5 p.m.:—

John S. S. Brame, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." Three Lectures.

Lecture I.—November 27.—The economic importance of coal—Enhanced importance in war time—Coal: the munition of war—The movement for economy—The output of coal and consumption for various purposes—Duration of supplies and economical considerations in relation to other countries—Other alternative sources of energy.

Lecture II.—December 4.—Recent developments in knowledge of composition of coal—Coal as a heating agent—As source of power—For domestic heating, etc.—The by-products from coal distillation, their relation to industry, and particularly as raw materials for munitions of war.

Lecture III.—December 11.—Directions in which economy may be realised—Economy in production—The utilisation of small and low-grade coal—Improvements by suitable preparation for market—Economy in use—By-product recovery—Economies possible from centralised systems of power generation: from extended use of carbonised coal, including gas—Low temperature carbonising schemes.

William Ripper, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

Cantor Lectures.

Monday afternoons, at 4.30 p.m.:—

Professor A. Beresford Pite, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

Juvenile Lectures.

Wednesday afternoons, at 3 p.m.:—

Alan A. Campbell Swinton, F.R.S., "Electricity and its Applications." Two Lectures.

January 3, 10.

MEETINGS FOR THE ENSUING WEEK.

Monday, November 27...Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. (Howard Lecture.) Professor J. S. S. Brame, "Coal and its Economic Utilisation." (Lecture I.)

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m. Inaugural Address by the President, Mr. S. G. Warner.

Tuesday, November 28...Swiney Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture VII.)

Photographic Society, 35, Russell-square, W.C., 7 p.m. Rev. E. C. Pitt-Johnson, "A Holiday in the Alps."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Professor G. E. Smith, "The common objections to the reality of the Migrations of Early Culture, with special reference to the Dogma of the similarity of the working of the Human Mind."

Wednesday, November 29...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Dr. Dugald Clerk, "The Internal-Combustion Engine."

Thursday, November 30...Swiney Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture VIII.)

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Mr. J. Small, (*a*) "On the Floral Anatomy of some Compositae"; (*b*) "Demonstration on the Force for dispersal of Fruits." 2. Mr. T. A. Dymes, "A note on the Seed of *Iris Pseudacorus*, Linn."

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. F. Martin Duncan, "Some Huns of the Insect World."

Friday, December 1...Swiney Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture IX.)

Saturday, December 2...Geologists' Association, University College, W.C., 3 p.m. Mr. H. Bury, "The Palaeoliths of Farnham."

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FRIDAY, DECEMBER 1, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 4th, at 5 p.m. (Howard Lecture.) JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." (Lecture II.)

WEDNESDAY, DECEMBER 6th, at 4.30 p.m. (Ordinary Meeting.) C. M. WHITTAKER, B.Sc., "The Coal-Tar Colour Industry." SIR WILLIAM A. TILDEN, D.Sc., LL.D., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

HOWARD LECTURE.

On Monday afternoon, November 27th, Mr. JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, delivered the first lecture of his course on "Coal and its Economic Utilisation."

The lectures will be published in the *Journal* during the Christmas recess.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, November 29th, 1916; The HON. SIR CHARLES A. PARSONS, K.C.B., LL.D., D.Sc., F.R.S., in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Collett, Leopold George, Merle House, Evesham.

Deas, Edmund Percy, 52, Larkspur-terrace, Newcastle-upon-Tyne.

Notley, Miss Mabel Emily, Larksfield, Englefield Green, Surrey.

Pegler, Alfred, 81, Palace-road, Streatham Hill, London, S.W.

Souza, Francis Xavier Da Silva e, 17, Nakayamate dori, Nichome, Kobe, Japan.

The following candidates were balloted for and duly elected Fellows of the Society :—

Barstow, Hon. George Eames, Barstow, Texas, U.S.A.

Brooker, Hon. Charles Frederick, A.M., The American Brass Company, Ansonia, Connecticut, U.S.A.

Cameron, Alexander, Government Dockyard, Massaruni, British Guiana.

Carver, George W., The Tuskegee Normal and Industrial Institute, Tuskegee, Alabama, U.S.A.

Clerk, Mrs. Dugald, Lukyns, Ewhurst, Surrey.

Cossar, Wilayat Hussain, The Watan, Lahore, India; and The University, Glasgow.

Currimbhoy, Hon. Sir Fazulbhoy, 13, Esplanade-road, Bombay, India.

Daubeney, Rev. A. R. Vaughan, East Walton Vicarage, King's Lynn.

Dhar, His Highness the Raja of, K.C.S.I., Dhar, India.

Eddy, Charles B., 62, Cedar-street, New York City, U.S.A.

Fenimore, Miss Beulah A., 147, Manheim-street, Philadelphia, Pennsylvania, U.S.A.

Garrett, Miss Mary S., Belmont and Monument Avenues, Philadelphia, Pennsylvania, U.S.A.

Glynes, Webster, Hamston House, Kensington-court-place, W.

Goodwin, William V'Alters Summers Gradwell, J.P., F.G.S., Red Heath, Silverdale, Staffordshire.

Greenwood, Thomas, 10, John-street, Hill-street, Mayfair, W.

Haidar, Haji Saiyid Jalaluddin, M.A., Aitchison Chiefs' College, Lahore, India.

Higgin, William Henry, B.Sc., The Elms, Parkstone, Dorset.

Holeman, Frederick Alfred, M.I.E.S., Jibutil Gold Mines, Morriston P.O., South India.

Horsfeld, H. E., Cuttack, Orissa, India.

Humphreys, J. Charlton, Junior Athenæum Club, 116, Piccadilly, S.W.

Hutton, J. Arthur, 15, Cross-street, Manchester.

Kershaw, Louis James, C.I.E., India Office, Whitehall, S.W.

Khan, Syed Ahmad Ali, Salimpur, Lucknow, India.

Lenygon, Henry, 31, Old Burlington-street, W.; and 16, East 60th Street, New York City, U.S.A.

Limaye, Professor Hari Govind, Fergusson College, Poona City, India.

Lockington, A. H., 1, Howard-road, Westbury, Bristol.

Mackenzie, James, Messrs. Macneill & Co., Calcutta, India.

Marston, Edwin S., 22, William-street, New York City, U.S.A.

Muir, Peter Gillespie, M.I.E.S., Calle Espartero 35, Ferrol, Spain.

Mukerjee, Haridas, Victoria Cottage, 14/3, Upper Circular-road, Calcutta, India.

Murdoch, Frederick Teed, British Consular Agent, Mansourah, Egypt; and Nile Lodge, Queen's Walk, Ealing, W.

Myers, Dudley B., Junior Carlton Club, Pall Mall, S.W.

Myers, Horace, The Sugar Wharf, 188, Harbour-street, Kingston, Jamaica, British West Indies.

Noel, Miss Emilia Frances, 37, Moscow-court, W.

Panday, H., B.A., Archæological Survey, Eastern Circle, Bankipur, India.

Pill, John R. G., M.Am.Soc.C.E., Corona, Alabama, U.S.A.

Rathbone, George, J.P., Ivy Lodge, Aigburth, Liverpool.

Roberts, William Henry, Hollin Royd, Victoria Drive, Eastbourne.

Scott, Henry, A.M.I.Mech.E., M.I.E.S., P.O. Box 42, Te Kuiti, New Zealand.

Shrosbree, Albert de Bois, F.S.I., 5, Clive-street, Calcutta, India.

Singh, Bhagat Lakshman, Government High School, Bhera, Shahpur District, Punjab, India.

Spencer, Professor Matthew Lyle, A.M., Ph.D., 8, Alton-court, Appleton, Wisconsin, U.S.A.

Surridge, William Alfred, 167, Auckland-road, Upper Norwood, S.E.

Tagore, Ranendra Mohun, Purana Baree, 6, Raghunundun-lane, Calcutta, India.

Tearoe, James, M.Inst.C.E., M.I.Mech.E., 409 and 410, Strand, W.C.

Thompson, Colonel Robert Means, Wall-street Exchange Building, 43, Exchange-place, New York City, U.S.A.

Timson, Rowland Clunbury, "And," Greenway, Berkhamsted, Herts.

Watson, Charles Cuningham, C.I.E., Commissioner's House, Ajmer, India.

Whymark, George Harvey, 7, Kyo-Machi, Kobe, Japan.

Wills, Miss Elizabeth, 10, Rock-street, Fall River, Massachusetts, U.S.A.

The Chairman said he had been called on to perform the pleasant duty of presiding at the meeting that afternoon, when the paper was read by the Chairman of Council, his old friend, Dr. Dugald Clerk. The subject of his paper was one which had occupied a great deal of his personal attention for many years, and with which his name was closely, and would ever be, associated. It was almost thirty-six years ago that he first had the pleasure of meeting Dr. Dugald Clerk under kindred and stimulating circumstances. He found him in his workshop at Glasgow, hard at work with his coat off and his hands were greasy and black, as an inventor's should be. He was working assiduously at his new gas engine, and he had explained to him (Sir Charles) its construction, its ingenious platinum ignition apparatus, and its two-cycle system of operation—a system now universally called the Clerk cycle—on which system many thousands of engines were now at work all over the world on land and at sea. The internal-combustion engine today ranked among the most important prime movers, and it was also the most economical in the conversion of the energy in oil or gas into mechanical work. Upon it depended all aircraft and nearly all submarines, and motor transport of all descriptions. Indeed for small and moderate powers its use was almost universal. It had become an ever-present part of our modern life, and was exercising on the community at large an educational influence in mechanics and engineering far greater than we were accustomed to suppose. It was a very important subject and one of which Dr. Clerk was a master. He took the opportunity of saying that in the near future Dr. Clerk would be assuming a very important Government position in connection with certain developments in this country. More than that he would not say then.

The paper read was—

THE INTERNAL-COMBUSTION ENGINE.*

By Dugald Clerk, D.Sc., F.R.S., M.Inst.C.E.

Motive power is of fundamental importance to industrial civilisation: without steam, internal combustion, and hydraulic power it would be impossible to support at all the forty-six

* First delivered in the Town Hall, Newcastle-on-Tyne, on September 4th, 1916, at the Meeting of the British Association.

millions of people now living in fair comfort on our small islands of Great Britain and Ireland. The labour of the scientific man, the engineer and the business man, in the long run, renders possible the very existence of this large and dense population.

The important part taken by us in the origin and development of steam motive-power is well known, and it is generally recognised that Britain stands supreme in all that relates to steam engines from the time of the condensing engine of James Watt to the steam turbines of the Hon. Sir Charles Parsons. All the intermediate stages—expansion, high pressures, compounding, tripling, and super-heating—originated in these islands. The application to pumping, mill-driving, marine navigation, and locomotive engineering began and developed here. Although the credit of steam invention is conceded to us, many of our general public and some of our engineers seem unaware of the leading part taken by England in that great field of invention covered by internal-combustion engines; they imagine that in this subject we are wholly indebted to Germany, and that the work of invention here is small compared to that of the Continent. This impression has arisen because of the indefatigable propaganda of scientific engineering Germany and the distinct bias to German methods shown by some of our prominent men. We are freely given to self-criticism, and no doubt in time of peace this characteristic is quite beneficial and useful in maintaining the desire to improve; but in times of war and change it is as harmful to underrate our own strength and achievements as it is to underrate the power of our enemies.

In the development of internal-combustion engines we have borne our full share of pioneer work. It is true that effort both in the past and present is more uniformly distributed among the nations in this field than in steam, but we hold our own in the competition towards more perfect thermodynamic methods and machines.

A very short review of the past will convince you that much has been done by England to develop engines fit for the great modern uses of stationary power production, land and water locomotion, and last, light and powerful engines for flight. The subject is one to which I have devoted much attention for the past forty years, during which these engines have developed from mere toys of one-half to three horse-power to engines of the thousands of horse-power of to-day. During that time there have been produced heavy engines for stationary purposes, light engines for motor-cars and flight, and intermediate engines for ship propulsion—all with the characteristic burning of the combustible gaseous or vapour fuel within the cylinder instead of within the boiler furnace.

My interest in the gas engine—as it was then called—began at the end of the year 1876. At that date the only types of engine in operation were the non-compression engine of Lenoir and the non-compression free piston engine of Otto and Langen. In 1876 the Lenoir engine had practically disappeared from commerce; a number were at work, but the only commercial engine was the Otto and Langen. This was a cumbersome engine, which operated with great noise and much recoil, and the largest of the type in existence did not develop more than three brake-horse-power. In that year the user of motive power had but little choice. He was practically confined to the steam engine, both for small and large powers. The motive power user of to-day is in a more fortunate position. Constructors of many types of motors compete for his favour.

These forty years have seen a marvellous development of the gas engine, and an extension of the use of different fuels has caused the old title "gas engine" to disappear in favour of the more general term "internal-combustion motor," lately shortened to "combustion motor," which includes all engines known as gas, petrol, and oil motors.

The gas engine originated, as its title shows, in a form of machine adapted to burn the coal gas of our towns; for many years past other inflammable gases have been consumed, such as producer gas in its various forms, generated from anthracite, coke, bituminous coal, and waste combustible solids like wood chips, sawdust, spent tan, and coconut shells, also coke oven gas and blast furnace gas; light volatile hydrocarbons are used, such as petrol and benzole; heavy hydrocarbons and sometimes coal tar. Even alcohol is applied to the purpose of actuating such engines.

In 1876 the total power generated by gas engines in the United Kingdom did not exceed 2,000 b.h.p., while in 1907 the final report of the first census of production of the United Kingdom shows that factories alone had at work a total of 680,177 h.p., while agriculture employed 98,785 h.p. of gas, petrol and oil engines.

In addition to this there were in use in motor-cars and motor-cycles not less than 750,000 h.p.

generated by petrol engines. The total power generated by internal combustion was thus:—

	Horse-power.
In factories, stationary gas, oil and petrol engines	680,177
For agriculture, stationary gas, oil and petrol engines	98,785
For motor-cars and cycles . . .	750,000
	1,528,962

In the United Kingdom a total of over 1½ million h.p. combustion engines thus existed in the year 1907.

An inquiry made in Germany in the same year showed a total of 351,000 h.p. of stationary combustion engines in operation in factories, and the total number of motor vehicles in use was 27,026, of which about one-half were motor-cycles. The total power of the locomotive petrol engines was not more than 180,000 h.p.

The total power generated by internal combustion was thus:—

	Horse-power.
In factories, stationary gas, oil and petrol engines	351,000
For motor-cars and cycles . . .	180,000
	531,000

In Germany a total of 531,000 h.p. combustion engines existed in 1907, a little more than one-third of the similar power of the United Kingdom.

The census of production of the United States of America for 1909 shows that there were in use 1,299,021 h.p. of gas and gasoline engines for the stationary work of manufactures and mines.

Nearly 115,000 motor-cars were produced in that year; this, with the vehicles in use, required engines of a total of about 1·2 million h.p.

Total combustion power for the United States was certainly not short of 2·5 million h.p.

The internal combustion power in these three countries during 1907 and 1909 was:—

		Million horse-power.
1909.	United States of America . .	2·5
1907.	United Kingdom of Great Britain and Ireland	1·53
1907.	Germany	·53
		4·56

—over 4½ million h.p.

Allowing for the increase of Britain and Germany from 1907 to 1909, a probable value for the total combustion power of the three nations in 1909 is 5 million h.p.

In 1909 France had 46,000 motor-cars in use of an average of about 13 h.p., or a total of 598,000 h.p.

The power of stationary combustion engines in France is not available, but the four countries show a total of at least 5¾ millions in 1909.

This figure does not include oil and petrol engines used for marine purposes, which probably brings the total up to 6 millions.

In 1909, then, we find at least 6 million h.p. of gas, oil, and petrol engines in the world—a truly great development since 1876.

In the year 1909 America led the world in the power of such engines at work, Great Britain came second, and France and Germany were nearly equal with the third place; and although great expansion has taken place in all these countries, Germany still retains the same relative position—America and England still lead.

In addition to internal combustion all these engines have another feature in common—all compress the working fluid before combustion; some compress an inflammable mixture and fire the compressed mixture, producing a mild explosion with a strictly limited possible rise of pressure; some compress air alone and then mix at the temperature of compression the inflammable gas or vapour and ignite as before; and some compress the air charge so highly that on the injection of oil fuel in a state of very fine spray the heat of compression causes the ignition of the spray as it enters the cylinder—such engines do not produce an explosion; the pressure within the cylinder never exceeds the pressure of compression or the pressure of the compressed air sometimes used to pulverise or disperse the liquid oil.

The engines operated by explosion are called constant volume engines, and those actuated by expansion, due to flame, constant pressure engines. Constant volume and constant pressure define the thermodynamic characteristics of the engines, but the mechanical cycle adopted to carry out in practice the necessary charging, compressing, igniting, expanding, and exhausting operations are varied. Two mechanical cycles are in general use: in one the motor piston and cylinder alternately act as pump and motor, so that four single strokes are necessary respectively for charging, compressing, expanding after igniting, and exhausting; in the other these operations are performed in two single strokes of a piston; air or the charge, however, has to be pumped and lightly compressed by a separate lighter piston or by the front of the motor piston. All existing gas, oil and petrol engines, whether light or heavy, operate

according to one of these cycles—the majority of engines in accordance with the four-stroke system.

This feature of compression before ignition is necessary in order to provide an economical engine expanding the gases of explosion in the most favourable manner and at the same time producing large power for small bulk. This mode of operation was the invention of an English engineer so far back as 1838. It will be found described in Wm. Barnett's Patent No. 7615 of 1838, where he gives full particulars of a double-acting internal-combustion engine having separate air and gas pumps, which supply a charge under light pressure to a motor cylinder, in which there acts a piston overrunning a large port in the middle of the stroke. The charge displaces the products of the previous explosion, and is compressed by the return of the piston into a combustion space left at the end of the cylinder. Barnett had fully realised the advantages of compression before ignition, and proposed in accurate detail an engine closely resembling modern two-stroke engines. He was the originator of both the compression idea in its present form and the two-stroke cycle of operation.

The first German engineer to appreciate the advantages of compression was Gustav Schmidt, but he did this twenty-three years later than Barnett, in a paper read before the Society of German Engineers in 1861. Schmidt states, criticising the Lenoir non-compression engine: "The results would be far more favourable if compression pumps, worked from the engine, compressed the cold air and cold gas to three atmospheres before entrance into the cylinder; by this a great expansion and transformation of heat is possible."

Million, a clever Frenchman, in his Patent No. 1840 of 1861, shows that he had exceedingly clear ideas of the advantage of compression; he evidently considers himself as first to propose its use in a gas engine, apparently unaware of the existence of Barnett's engine which I have just described. He claims the exclusive right to use compression in the most emphatic language. One engine described is exactly what Schmidt asked for. Separate pumps compress the air and gas into a reservoir, from which the movement of the motor piston, during a portion of the stroke, withdraws its charge under compression. Ignition is accomplished by the electric spark, and the piston moves forward under the high pressure produced.

He also describes a compression engine in which the motive cylinder is made longer than necessary, in order that the piston shall always leave between it and the end of the cylinder a space such as one-fourth or one-third of the volume generated by the motor piston. Here he resembles Barnett and the modern internal-combustion engines.

M. Alph. Beau de Rochas, a brilliant Frenchman, in a remarkably clever pamphlet published in Paris in 1862, discusses the conditions of economy in gas engines using compression with reference to volume of hot gas and cooling surface to which they are exposed.

He states that four conditions are necessary in order to obtain the maximum economy in a compression explosion engine:—

1. The greatest possible cylinder volume with least possible cooling surface;
2. The greatest possible rapidity of expansion;
3. The greatest possible expansion; and
4. The greatest possible pressure at the commencement of the expansion.

He therefore reasons that a large cylinder is necessary, and the time of exposure to cooling should be as short as possible and piston speed high.

He considers that the sole arrangement capable of meeting the conditions is a single-cylinder engine having the following series of operations:—

1. Suction during an entire out-stroke of the piston;
2. Compression during the following in-stroke;
3. Ignition at the dead point and expansion during the third stroke;
4. Forcing out of the burned gases on the fourth and last return stroke.

The ignition he proposes to accomplish by increase of temperature due to compression. This he expected to do by compressing to one-fourth of the original volume. He also proposes a double-acting engine of the same type with piston rod and stuffing box.

Beau de Rochas' proposal had to wait for fourteen years before it was put into successful practice. The late Dr. N. A. Otto, of Cologne, succeeded in overcoming the practical difficulties in the year 1876, when he produced the first commercially successful gas engine utilising the idea of compression before ignition, first proposed thirty-eight years before by the English engineer Barnett, applied by the means of the cycle of operations due to Beau de Rochas. The modern four-stroke engine was thus the outcome of the English, French, and German brain. The world, however, remains deeply

indebted to the late Dr. Otto, whose ability and pertinacity, applied at the crucial time, produced an engine which marks an epoch in the advance of internal-combustion motors. Dr. Otto deserved his success; he had fought long and hardly for it. He was born at Holzhausen in Nassau in 1832; he began his work on gas engines in 1854 at twenty-two years of age; attained his first success—the Otto and Langen engine already referred to—in 1866; and made his epoch-making advance in 1876. He applied his whole life to the study and development of the gas engine, and died in the year 1891 at the age of fifty-nine, after thirty-seven years devoted to the problems of internal combustion.

Although in 1861 Schmidt in Germany and Million in France described compression engines with separate compressing pumps, no two-stroke engine appeared in public till 1879, when I exhibited my first compression gas engine at the Kilburn Show of the Royal Agricultural Society of England. This engine was patented in 1878 (Patent No. 3045). It had two cylinders, a pump and a motor, each of 5 in. diameter by 8 in. stroke. The pump compressed a mixture of gas and air into a reservoir at the full pressure required; the mixture was admitted to the motor cylinder during the first part of its stroke, cut off by valve and ignited by an incandescent platinum igniter, the piston driven forward by the explosion, and after expansion the return stroke of the piston discharged the exhaust gases. This engine was heavy for its power, and it was subject to the difficulty of back ignition into the reservoir, so that it was not placed on the market. The engine gave three brake-horse-power, however, for many months, and it is believed to be the first compression engine ever run giving one impulse for every two strokes of the motor piston.

The engine best known by my name was patented by me in 1881 (No. 1089 of 1881). It resembled Barnett's of 1838 in compressing within the cylinder and giving one power impulse for each double stroke; but it differed in applying exhaust ports at the out end of the stroke overrun by the piston to time exhaust and charging. It further differed in coupling the pump or displacer cylinder to the main crank shaft, instead of driving at twice the number of revolutions by gear wheels.

At the time when I was inventing, designing and experimenting with two-stroke engines in Glasgow, a Northumberland man, the late Mr. James Robson, was busily at work on compression. His first patent is dated 1877, No. 2334. It describes an engine of the non-compression type; but he produced a two-stroke engine with compression, under patents dated 1879 and 1880. Messrs. Tangye, of Birmingham, produced an engine with Mr. Robson, which was first exhibited in public by them at the end of 1880. In this engine the front end of the cylinder was enclosed and used as a pump to force a mixture of gas and air into a reservoir at a pressure of about 6 lb. per square inch above atmosphere; the piston over-ran ports in the cylinder, but the exhaust was not timed by it; a separate valve was used which controlled the exhaust.

Siemens in 1861, and Brayton in 1873, had proposed constant pressure engines, in which the front end of the cylinder was used to compress the charge which was utilised on the other side of the piston to produce power by combustion and expansion; but Robson was first to propose the use of the front to compress lightly the charge for the compression engine of the explosion type.

The two-stroke or impulse-per-revolution engine was thus the result of the work of the English engineer, Barnett, 1838; the French engineer, Million; and the German engineer, Schmidt, in 1861; and British engineers, Clerk and Robson—Clerk by his 1878 and 1881 engines, and Robson by his 1879 and 1880 engines.

Mr. Robson's son, Mr. James Robson, of Messrs. Tangyes, Ltd., published an interesting booklet last year describing his father's early work, from which it appears that Robson experimented with gas engines of different types from the early date of 1855, and he rightly claims priority for his father as the inventor of one type of two-stroke engine—that in which all the pumping and motor actions are performed by one piston in a single cylinder.

Undoubtedly Mr. Robson was very early in the field, and his work was most meritorious; but the existence of Barnett, Million, and Schmidt prevented any later inventor from claiming the whole idea of impulse-every revolution. Robson and Clerk both invented modifications which made the two-stroke idea practicable; but as the four-stroke cycle had been invented by Beau de Rochas, so the two-stroke idea was likewise proposed by the earlier inventors.

Messrs. Sterne & Co., engineers, Glasgow, built and sold large numbers of Clerk type two-stroke engines, and Messrs. Tangyes, of Birmingham, a large number of Robson engines.

The test of use and time, however, proved the four-stroke engine to be best adapted for most purposes, and by far the largest numbers of internal-combustion engines in existence operate according to this cycle.

Many of the larger gas engines in Germany and America operate upon the Clerk modification of two-stroke compression engine as adopted by Messrs. Kœrting, of Hanover, and their licensees. In the inquiry made in Germany referred to already, it was proved that 260,000 brake horse-power was produced in that country in the year 1907 by four-stroke engines, and 91,000 brake horse-power by two-stroke engines.

A modification of the Robson two-stroke engine was made in England by Mr. Day in 1891, in which a crank case was used as the pumping chamber, and the piston, by means of three cylinder ports, performed all the necessary valve operations. This form of engine is largely adopted in America for launch propulsion; some motor-cars also used it. An increasing use is being made of two-stroke engines for large gas and oil engines, and this type is now firmly established, and shares the field with four-stroke engines; both have advantages on some points and disadvantages in others.

The engineering and commercial development of the four-stroke engine proceeded simultaneously in England and Germany. The Messrs. Crossley, of Manchester, constructed many thousands of these engines, and as the result of study and experience they made numerous improvements of an important kind. The German works, the Gasmotoren Fabrik, of Cologne, under Dr. Otto, continued the work in Germany, and this company also constructed large numbers of engines; and Dr. Otto, Herr Daimler, his works manager, and others produced important modifications and improvements. All the numerous engine works established on the Continent and in America were enabled to work successfully from the experience produced in the first instance by these two firms. The early development of the engines, however, was seriously hampered by an erroneous theory of the action of the explosion under compression held by Dr. Otto and supported in Germany by a physicist even so learned as Dr. Slaby. This erroneous theory also received support from several English scientific men of eminence. According to Dr. Otto, all gas engines previous to his four-stroke motor of 1876 obtained their power from the explosion of the homogeneous charge of gas and air. By this explosion excessive heat was supposed to be evolved, and the pressures produced rapidly fell away and the excessive heat was rapidly absorbed by the enclosing cold walls. This, Dr. Otto said, caused great loss and gives very wasteful engines. The two methods were open to obtain better economy:—

1. By using a very rapid expansion so that the heat had but little time to be dissipated;

2. By using slow combustion, that is, by causing the inflammable mixture to evolve its heat slowly, so that the production of excessive temperatures and pressures was avoided.

The Otto and Langen engine, with its shooting piston, obtained its economy by long very rapid expansion; the Otto four-stroke compression engine was supposed to obtain its economy by a gradual evolution of heat throughout the stroke, produced, Dr. Otto thought, by the stratifying of a charge of gas and air in the cylinder. This false theory of the action of compression, if persisted in, would have blocked all improvement in power and economy upon the very moderate results obtained in 1876. The greater part of the credit of working out the true theory of operation of compression gas engines falls to Great Britain. A paper read by Clerk before the Institution of Civil Engineers in London early in 1882 discussed the theory of compression, and proved definitely and numerically the relative improvement in thermal efficiency to be expected by using compression previous to ignition. That paper, in fact, established the air standard of efficiency for internal-combustion motors. This was taken up later by Dr. Amie Witz, of Lille, and the whole subject was dealt with fully, so far as the knowledge at that time allowed, in a book published by Clerk in London in 1886. In that year also a paper was published at the Institution of Civil Engineers, also by Clerk, giving the results of investigations upon the different maximum pressures produced by mixtures of coal gas and air ignited at atmospheric pressure within a large closed vessel. In that paper the whole subject was dealt with quantitatively, and it was proved that the conditions of economy were, so far as explosion is concerned, due to the use of moderate temperatures produced by homogeneous explosive mixtures; stratification was proved to have nothing whatever to do with economy. Other investigators took up the work of Britain, and explosion experiments with various mixtures and pressures of gas and air were made both in American and German colleges which corroborated Clerk's results. The modern improvement

of thermal efficiency flows from a knowledge of the true theory of compression, and by the aid of abstract knowledge the indicated thermal efficiency in commercial internal-combustion motors has risen from 16 per cent.—Otto's results in 1876—to 35 to 40 per cent.—esults of high-compression engines used to-day. A very important portion of the work of investigation of the conditions of gaseous explosions is due to the Gaseous Explosions Committee of the British Association. That committee was formed at the Leicester Meeting in 1907, and a great deal of important experimental work has been accomplished by its members in the nine years which have elapsed.

Notes on experimental investigation into explosion temperatures; rates of temperature rise and fall; dissociation of steam and carbonic acid; radiation during chemical combination and after; variation of specific heat of air, nitrogen, carbonic acid and steam with increase of temperature; causes of varying rates of inflammation; comparing closed vessel explosions with engine cylinder explosions, temperatures of cylinder walls and pistons; composition of exhaust gases, suction and exhaust temperatures; variation of heat loss during expansion at differing gas densities; internal energy of gases at high and low temperatures, and many other matters have been submitted and discussed by Callender, Clerk, Coker, Dalby, Dixon, Petavel, Harker, Hopkinson and Watson.

Independent chemical work, too, has been accomplished by Bone, Dixon and Smithells, while Burstall has made additional investigations on temperatures. The properties of the working fluid of the internal-combustion engine at high and low temperatures have thus become known to the engineer and inventor to assist him in making further departures intended to increased the power of those motors to compete more and more with the very large steam turbines and reciprocating steam engines of to-day.

Five reports have been published by the British Association summarising these separate investigations.

Germany has also carried out some investigations, principally at the Reichsanstalt, in Berlin. On the whole, however, the German scientific work on this subject is much inferior in importance to the British. Most valuable French work has been also done from Regnault to Mallard and Le Chatelier, Berthelot and Witz.

Some American work has also been performed, but undoubtedly the English work on the nature of gaseous explosions dealing with questions of varying specific heat, rate of heat loss to walls, effect of polished inner surfaces, radiation effect, and the discussions on dissociation have proved of vital importance to the science of this subject. Curiously enough, the German scientific men are far behind in the theory of these motors, although their practical constructors have done excellent work, even with most erroneous ideas of the nature of the forces with which they were dealing.

The stationary internal-combustion engine industry grew very rapidly in England, and as will be seen from the figures already given, the German industry in 1907 was smaller than the English industry, and just before the war it is believed that the proportion of industrial engine work in England and Germany was practically the same as in 1907. An impression has grown in this country that Germany was more advanced in the application of internal-combustion power than we are here. This is due to the fact that the Germans have devoted much more attention to the large cylinder gas engine and oil engine than the British. English engineers have never been satisfied with the existing line of development of these large cylinder engines. From the scientific point of view they consider that the building of large engines practically without modifications of either thermodynamic or operative cycle was a costly mistake leading to development in a wrong direction. Accordingly in England more attention has been given to multi-cylinder engines than in Germany, the idea being to keep the dimensions of the cylinders as small as possible. By so doing, engines were produced of a greater power for a given weight of metal utilised. British engineers and scientific men are still convinced that other methods must be found of increasing power in internal-combustion engines than mere increase of dimensions of cylinders and massive construction of engine parts as practised in Germany. Undoubtedly a solution will be found which combines high powers with small weights. So far as stationary engines are concerned, cylinder for cylinder, the internal-combustion engine is at a disadvantage in weight for power compared to the steam engines without their boilers. A very large industry has been created in small cylinder engines, but the power unit attained as yet is not sufficiently great to compete with the larger steam engines, especially in the form of steam turbines. Notwithstanding the fact that English makers mainly confine themselves to smaller cylinder engines, it is a mistake to

assume, as is too often done, that the Germans are in advance of us in this line of work, either in practice, industry or science. While in Germany engineers paid great attention to larger cylinder engines, England was busy developing the smaller types adapted to use heavier oils, such as kerosene and paraffin. The first engine to attain success as a kerosene or paraffin engine was produced by Messrs. Priestman, of Hull, in 1885. Mr. Stuart Akroyd, in his patents of 1886 and 1888, described an engine which, in the hands of Messrs. Hornsby, has taken a most important position. In that engine air alone is taken into the cylinder of an internal-combustion engine through an inlet valve, and the combustion chamber is kept separate from the inflowing air by the device of using a chamber of bottle-neck construction, the bottle-neck opening into the cylinder. This bottle-neck combustion chamber is only partially water-jacketed, and one part of its surface can in the first instance be raised to a low red heat by means of a pressure lamp. The oil to be used is pumped into this combustion space during the suction stroke of the engine, but little or no mixture occurs until compression begins. The compression of the air by the piston on the return stroke forces the air charge to mix with the vaporised oil existing in the combustion space mixed with products of the previous ignition. The temperature of the hot wall is so adjusted that when compression is complete or nearly complete the mixture ignites and a moderate explosion pressure is produced. This type of engine is very successful, and is made in large numbers throughout the world. Other methods of operating internal-combustion engines have been experimented upon in this country by many inventors and manufacturers.

One set of experiments made by me possesses special interest. The experiments were made at Messrs. Tangyes' works in Birmingham at the end of 1887 and the beginning of 1888. In this engine the cylinder was charged with air on the two-stroke method which I have already described. The air was compressed into a space at the end of the cylinder, and coal gas was compressed by a separate pump. When the motor piston completed the compression of air, the gas pump forced a jet of compressed gas into the compressed air, and an igniting device was so arranged that this jet ignited as it entered the compressed air. No gas was added to the air until compression was complete. The diagrams produced by this engine closely resemble those of the steam engine—a rise at the beginning of the stroke, constant pressure for a certain forward part of the stroke, then cut off and expansion. The engine, in fact, was as I called it at the time, a flame-injection engine in which explosion was avoided altogether. This engine ran for six months and many tests were made. The explosion engine was held to have certain advantages which prevented this particular type from being put upon the market. Its interest arises from the fact that it was, I believe, the first engine operated by the injection of a flame jet into compressed air within a cylinder. Five years later Dr. Diesel, the distinguished German inventor, began work on an engine in which he compressed air through a range of about twelve. Compressing air to one-twelfth of its former volume sufficiently rapidly, raises the temperature of the air to about 600° C. Dr. Diesel then injected fine oil spray into this highly compressed hot air. The spray at once ignited, and a diagram very similar to the early Clerk diagram was produced, but at a much higher pressure with greater expansion, and therefore much greater economy.

Dr. Diesel was an able engineer of great pertinacity, and he succeeded in working through the great difficulties of this type of engine. It has, as we all know, become a most important feature of internal-combustion work. The Diesel type engines, with their high compression and automatic ignition, used for the first time very heavy oils in a most effective way. The Diesel engine undoubtedly fulfils important purposes in both stationary and marine work where oil can be had. Although it has taken an important place, and will continue to occupy an honourable position, its advocates have rather exaggerated its possibilities. The amount of oil in existence in the world is too small to allow of the future proposed by Diesel enthusiasts. For stationary purposes undoubtedly gaseous fuel prepared from coal or carbonaceous matter will maintain the leading position.

An interesting paper was read by Dr. Diesel at the Institution of Mechanical Engineers in the beginning of 1912, and in the discussion which followed, Diesel most honourably admitted the advantages he himself had derived in producing his engine from the study of earlier English work. Dr. Diesel's fate was a sad one. He worked with the utmost faithfulness and pertinacity from the initiation of his experiments in 1887 until his untimely death in 1913. He was lost, as you will remember, from the steamer "Dresden," on a passage between Antwerp and Harwich on September 29th, 1913.

Notwithstanding his strenuous and useful work he died in great monetary difficulties. The period of existence of his patent in Germany and England was insufficient to enable him to reap any reward for his persevering technical efforts. This has proved the fate of many inventors, and the more important the invention the more likely is it that the term of the patent expires before commercial success is attained. Great departures are made with difficulty, while small changes are easily and rapidly applied. In the early stages of the Diesel engine the inventor was under the impression that he could produce a motor which followed the Carnot cycle in its entirety. Such an engine requires compression to the full temperature necessary for the addition of heat, expansion for a certain distance at constant temperature, and then further expansion to the lowest temperature, the heat discharged being obtained by compression at the lowest temperature. Such a cycle of operations gives the maximum possible efficiency between certain heat limits. Diesel misapprehended the position, and he failed at first to see that the mean pressure obtained in such a cycle was very low compared to the maximum pressure necessary. Thus, with a maximum pressure of 500 lb. per square inch the mean pressure was only 6 lb. per square inch. Such an engine would be, under the assumption, a perfect thermodynamic machine; but unfortunately it would give no power — friction would be too great. Accordingly the claim made by the supporters of Diesel in its early stages to a superior thermodynamic cycle from that of ordinary explosion compression gas engines falls to the ground. As a matter of fact the Diesel cycle has a smaller efficiency for a given compression than the explosion cycle.

Had coal gas been the only fuel possible for internal combustion engines it could not have attained its position of to-day. In providing other gases for this purpose England also led the way. Mr. J. E. Dowson, in 1881, constructed a gas producer, using anthracite, which operated by passing a mixture of steam and air over the incandescent anthracite. The gases leaving this apparatus contained hydrogen, carbonic oxide, some carbonic acid, nitrogen, and a little oxygen; and when cooled evolved on combustion about 160 B.Th.U. per cubic foot.

The pressure gas producer which he first exhibited, operated a Crossley gas engine in the year 1881 at the York meeting of the British Association. The invention of the Dowson pressure producer extended the sphere of these engines in a very material way, and led to the construction of what are called suction producers, operated without steam boilers or pressure blowers. Such producers have been applied very extensively in Britain and all over the world in units of from about 20 to 500 h.p. The suction modification was operated at first in France by the well-known engineer, Benier, in 1894, and the French development was continued in England and in Germany about eight years later.

England, too, led in the use of bituminous fuel producers; the late Dr. Ludwig Mond, of Brunner, Mond & Co., devoted much time and effort to the production of large plants capable of gasifying bituminous fuels. In the larger plants Dr. Mond included devices for the chemical recovery of ammonia and the production of sulphate of ammonia. This work of Mond's has been most important, and many large installations of gas engines are now in operation up to about 3,000 h.p. using gas from Mond plant.

An English inventor, the late Mr. B. H. Thwaite, in 1895 made an important experiment in the application of the waste blast furnace gas to the purpose of power production. His first plants were installed at the Glasgow Iron Works and at Barrow-in-Furness, and the idea was soon taken up at the great Belgian works of Messrs. Cockerill. There the large cylinder gas engine was first developed. About 1900 an engine of 51-in. cylinder diameter was exhibited as applied to blowing for blast furnaces. This engine was the result of the work of M. Delamare Debouteville. This was the beginning of the large cylinder movement on the Continent. It was taken up in Germany by the Deutz Works, Cologne, and by the Oechelhauser Company. America followed, and in England, too, several makers devoted considerable attention to the large cylinder engines. The large cylinder movement has, however, undoubtedly prospered more on the Continent and in America than in this country. The extent of the trade, however, is not very great compared to the trade in small cylinder engines; and it is to be hoped that the efforts of British and other engineers will be successful in producing more powerful engines of less weight and bulk. The present large cylinder engine solution is by no means satisfactory, either to the engineer or to the scientific man.

The leading names in German invention and design are thus Otto, Daimler, Diesel, Oechelhauser, and Koerting.

British work in this line was accomplished by

Crossley, Clerk, Robson, Atkinson, Humphrey, Priestman, Akroyd Stuart, Hornsby, Dowson, Mond and Thwaite.

The four-stroke Otto engine, it will be seen, was adopted in England by Messrs. Crossley, and the two-stroke engines of Clerk and Robson were adopted in Germany by Koerting and Oechelhauser.

Of the German inventors, Otto is by far the most important. Daimler's merit consisted in his appreciation of the fact that a four-stroke engine of small dimensions could be safely run at a high speed of rotation; and his little petrol motors, from their relatively light weight and high power, were rapidly adapted by Germans, French and Belgians to the purpose of motor-car propulsion. England, unfortunately, was hampered by an absurd law which required mechanically-propelled vehicles to be preceded on the road by a man carrying a red flag. This red flag Act was not repealed until 1896, so that after that date Britain rapidly gained headway in the construction of the very small cylinder petrol engine, and by its designers and scientific investigators shared fully in the modern development of the motor-car and the aeroplane. The aeroplane became practicable by the genius of the brothers Wilbur and Orville Wright in the United States in the year 1906. They were the first successfully to apply a petrol engine to a mechanical glider. America and France led the way with the aeroplane and the modifications of engine required for aeroplanes until 1909, when the Government Advisory Committee on Aeronautics was started, and the same year saw the beginning of the Royal Aircraft Factory. Another body, the National Physical Laboratory, in conjunction with these two institutions, made numerous experiments on the different factors required in flight. The co-operation of the three bodies in conjunction with the manufacturers of Britain resulted in the highly successful British aeroplane of to-day.

The industry devoted to stationary gas engines, oil engines, and petrol motors in Britain is now very large. An indication of the relative development in England and Germany is given by the comparison, by a well-known Belgian consulting engineer, Mr. R. E. Mathot, of the production of the Gasmotoren Fabrik Deutz and its licensees in Germany with the production of Messrs. Crossley Brothers, Ltd., of Manchester, up to the year 1909. The German firm up to the end of that year had completed altogether 410,098 h.p. of stationary gas engines. The English firm had built 1,020,230 h.p., and this formed but a small part of the output of Britain. From this it must be evident to you that, acting in our own independent manner, Britain has accomplished a large share of the work of the development of the modern internal-combustion engine, both in design, construction, commercial manufacture and development of scientific knowledge. In some fields more work has been done in Germany, in others more in Britain.

So far I have discussed only the development during the modern period, that is, since 1876, but an earlier examination shows that as usual English inventors were very much alive to the necessity of improving the means of obtaining motive power. England and France in the early stage were at work long before Germany. This even the German text-books acknowledge. In an important German work, written by a well-known German engineer, Herr Hugo Güldner, and published in 1903, I find the list of early inventors as follows:—

1791. John Barber, English Patent No. 1833.
1794. Robert Street, English Patent No. 1983.
1801. Lebon, French Patent No. 1799.
1823. Samuel Brown, English Patent No. 4874.
1833. Wellmann Wright, English Patent No. 6525.
1838. William Barnett, English Patent No. 7615.
1841. James Johnston, English Patent No. 8841.
1842. Drake, English Patent No. 562.
1852. Christian Reithmann, experimental four-stroke engine built in Munich.
1854. Barsanti and Matteucci, English Patent No. 1655.
1858. Degrand, French Patent No. 21301.

It will be observed that German industry appears under the name of Christian Reithmann for the first time in 1852. There are other early English inventors who do not appear in the patent lists. Professor Farish, Professor of Physics in Cambridge University, described an engine of the Lenoir type and showed a model working upon his lecture table as early as 1817. The Rev. W. Cecil, of Cambridge, produced an interesting atmospheric gas engine in 1820, and read a paper fully describing it before the Cambridge Philosophical Society in that year.

From this examination it will be seen that the internal-combustion engine, like all great inventions, is the result of a long-continued struggle, and much thought and ingenuity, the outcome of the work of men of many nations.

It is indeed rare to find an invention which can be considered as entirely novel. A search through the records of the past invariably shows tentative efforts to produce a given result. The early efforts always failed, partly from want of fundamental knowledge—in the case of the gas engine, ignorance of the properties of gaseous explosions—and partly from the lack of engineering means of carrying inventions into practicable effect. It is one thing to conceive an idea and quite another matter to carry it into effect in actual operative iron and steel. In the early days of engines constructive appliances were exceedingly imperfect; and, accordingly, we find James Watt rejoicing when he gets a cylinder bored sufficiently true to prevent the passage of a coin between the cylinder and the piston at any point of the stroke. Great work had to be done, and progress in machine tools made before it was possible to bore cylinders with the accuracy required in modern gas and oil engines. Progress is now more rapid on the constructive side, because machine tools are capable of an accuracy measured in thousandths of an inch, and also because of advancing knowledge of the nature of the working fluid, flame, which acts in the interior of those cylinders. The advance, too, of thermodynamics and the better understanding of limits of efficiency prevent inventors from following false paths. Accordingly we may expect further rapid advance in these motors during the next decade.

In this great subject, as in others, we have a right to be encouraged by the story of past effort and the realisation of the present, to look forward to a future in which Britain will perform her full share in the work of development and production. Broadly, development has been great and general, and the field of the reciprocating steam engine has been effectively invaded for both stationary and locomotive purposes on land and water. The steam engine in its various forms, however, still supplies much the largest proportion of motive power. The United Kingdom had stationary engines for manufactures and agriculture in 1907 of about 10·8 million h.p.; the United States had in 1909 about 23¼ million h.p., similarly mostly steam engines. Of this, in Britain, internal-combustion engines gave about 6·4 per cent. and America, about 4·2 per cent. The engines on the ships of the world have a power of about 24 million h.p., a very small proportion internal combustion. The younger engineer of to-day has a huge field of effort open to him, and he will need all the scientific and practical knowledge available to fit him for his task. His position is enviable compared to that of the pioneers, and his progress should be rapid and great. The older combustion engineers have justified their faith and earned an honourable position among the workers of the world.

The fate of the British Empire in the future depends upon the scientific engineer; our present existence as a free nation depends upon our sailors and soldiers; but the more distant future is subject more to the efforts of engineers than to the labours of war or politics.

DISCUSSION.

THE CHAIRMAN (the Hon. Sir Charles A. Parsons, K.C.B., LL.D., D.Sc., F.R.S.), in announcing that the discussion was open, said the paper was a thoroughly sound one on a very difficult subject. It was very comforting to hear Dr. Clerk say that Britain had been in the forefront of gas engine developments, and that there was a larger proportion of gas engines in England and America than in Germany. The question of the large cylinder versus the small cylinder was a subject of very great discussion in this country about two years before the war. The Germans believed that the large cylinder engine was the best type, and some said that we were very much behindhand, and that British engineers and British workmen were incapable of making a successful large gas engine. But the experiments of scientists like Clerk, Hopkinson and Dalby showed that in the large cylinder the heat transmitted to the walls was very much more intense than in the small cylinder. In fact, other things being equal, the heat varied roughly as the square root of the dimensions of the cylinder. Therefore, in a certain size of cylinder, say 200 h.p. or 300 h.p., the heat became so intense that no metal would stand it. The surface of the metal was heated to such an extent that it was compressed beyond its elastic limit, and on cooling it was submitted to a tension beyond its elastic limit, so that hair cracks made their appearance all over the surface, and eventually the crack went right through and the cylinder burst. Steel was worse than cast-iron in this respect. Thus the Germans were wrong as regards the large cylinder, and the English, who were conservative, took the right course, and did not go in to any extent for large cylinders. Further, our experiments showed that the weight per horse-power increases very rapidly as the cylinder increases beyond a certain small size, so that the only way to get a very light engine of large power was to have a great number of small cylinders—in other words, a multi-cylinder engine—and collect the power either by gearing or any other means on the

shaft to be driven. That had not been carried out to any extent in ships, and in this direction, undoubtedly, there was a field open to the engineers.

PROFESSOR E. G. COKER, speaking with reference to the Gaseous Explosions Committee of the British Association, said Dr. Clerk had mentioned that the Committee had been working for nine years, but he did not say—he could not very well have done so—that all through those nine or ten years it was he who had been the inspiring influence. Dr. Clerk had gathered together a number of people interested in the gas engine, both engineers and chemists, and kept them all very busy for a good many years working on different problems, the nature of which he had indicated, until the outbreak of the war, when the Committee was not able to continue the activities it was then engaged upon. All the members of the Committee, however, hoped that after the war the Committee would carry on its work as before. There was one point concerning which Dr. Clerk would do the audience a favour if he would say something upon it, and that was what had happened in regard to the gas turbine since, he believed it was, the Leicester meeting of the British Association. At that particular time they had been promised a paper by a German engineer on the 1,000 h.p. gas turbine, which was going to be a great revolution on anything that had been done before. They had been promised some very high efficiencies; but the paper did not arrive, and he did not remember hearing anything about it since. He believed some experiments had been made later, and would be glad to hear what progress had been made since that time.

MR. A. EVANS, referring to the Hornsby or Stuart Akroyd engine reminded the author that in describing this he said that the oil was injected into the combustion chamber while the air was being drawn into the main cylinder. He was under the impression that, although that was the practice in the ordinary Hornsby engine, at the beginning of the Stuart Akroyd invention the oil was injected into the cylinder at the moment of highest compression. In other words, Stuart Akroyd had anticipated what was now known on the market as the semi-Diesel engine. Another point was whether Dr. Clerk had not made a mistake when, in speaking of the Daimler engine, he said that the governor worked on the exhaust valve and kept the valve open when it wanted to cut the engine out again and otherwise let it function in the usual way. He was under the impression that that valve was kept closed.

MR. W. L. OAKDEN asked which internal-combustion engine had attained the highest efficiency, and how that efficiency compared with the best efficiency of any other kind of engine.

DR. DUGALD CLERK said he had had much pleasure in working with Professor Coker and the other members of the British Association Committee. They had been able to carry out many experiments and were proud to find they had discovered many things which the Germans had failed to do. With regard to the gas turbine, Professor Coker was referring to the Holzworth turbine. At the Dundee meeting of the British Association he had been asked to give a short note to the Engineering Section on the gas turbine. In connection with that he asked Herr Holzworth, who said he was coming to the meeting, to give some of the results obtained with his 1,000 h.p. gas turbine. He also asked him if he would answer a few questions which he sent him, concerning efficiency, total power, etc. Just before the meeting he got a wire which gave a much lower efficiency and much lower power than had ever been given before in the published information on the subject, and it was quite evident that in 1912 the experiments were a failure. He had heard since that greater success had been obtained, but on the cycle they were operating with in 1912 they could not possibly equal the efficiency of the steam turbine. People seemed under some misapprehension on the matter of the gas turbine. It was not the faintest use designing such a machine unless some of the advantages of the internal-combustion engine were obtained. The great advantage of the internal-combustion engine was that a higher thermal efficiency could be got than by any thermodynamic method yet discovered. The steam turbine had made marvellous progress, but efficiencies were not high efficiencies from the thermal point of view; they did not equal those of the internal-combustion engine. If a combustion turbine were made giving an efficiency something like that of the steam turbine, it was no use attempting to put it on the market, because the steam turbine had practical advantages. For instance, the temperature conditions were very much easier, whereas the temperature conditions of the gas turbine were very onerous. So far as he knew, the gas turbine had not yet succeeded, although it might do so in the future. As to the method of injection in the Hornsby oil engine, he was called in to test the Stuart Akroyd engine at a very early stage, and that was an engine in which the oil was injected during the suction stroke, and compression took place and the ignition occurred exactly as he had described it. There had been attempts to work the other way, but, so far as practical matters were concerned, they were a failure. There was a good deal of misapprehension about this question of the injection of fuel into air, and a great many people claimed the origin of the Diesel engine. As a matter of fact there were many specifications describing the exact operations of what Mr. Stuart Akroyd called the injection of fuel into the air. One was a Liverpool inventor who was some years before Stuart Akroyd, and long before Diesel. There was nothing new in it, and there were many patents in which the compression was accomplished with air only, and the heat of the walls of the cylinder was sufficient to cause

ignition. Where they all failed, and indeed where Diesel himself at first failed, was in realising the necessity of producing intensely as fine spray, the fuel required. Dr. Diesel had told him that his first experiments were a complete failure because he had not a fine spray. He worked his engine, and could not get a single ignition, until one day he got a terrible explosion and blew the top off his cylinder, and was very much encouraged. That led him to study some of the earlier work, and he discovered that the fine spray was the main point. In none of the engines before Diesel had that been appreciated. As far as he knew, the first engine to work with flame injection was his own in 1887; but even then the economy was not equal to the ordinary explosion, but the Diesel idea was to get compressed air hot enough to ignite the finely-sprayed fuel. Diesel certainly succeeded in using a heavier fuel than could be used in other types. The suggestion with regard to the valve of the Daimler engine was correct. The valve was kept closed. As to the efficiency of internal-combustion engines, there was nothing to choose between the Diesel and the ordinary explosion engine in the matter of brake thermal efficiency. If indicated thermal efficiency was disregarded, it would be found that brake thermal efficiencies of the order of 30 or 31 per cent. were obtained, but the indicated efficiency was increased because the compression of the air for the spray producer was never taken in, and Dr. Diesel himself at the Institution of Mechanical Engineers admitted that the German method of calculation was wrong and gave too high an efficiency. With the Diesel engine the brake efficiency was the true efficiency. The mechanical efficiency of the Diesel engine was generally exceedingly low, something of the order of 75 per cent. against 86 per cent. in an ordinary combustion engine.

A hearty vote of thanks was accorded Dr. Clerk for his paper.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

State Wool.—The acquisition by the State of the season's supply of British home-grown wools, representing about 122,000,000 lb., is a small transaction by comparison with the purchase of probably 700,000,000 lb. forthcoming from Australia and New Zealand during this season. The bargain may be estimated at £40,000,000 cost price, for wool which at market price should be worth £50,000,000. Of the several lights in which the operation might be regarded, the most important is evidently the Imperial one, and the purchase marks a notable development in the husbanding of the resources of the Empire for the purposes of war. Control of the use, destination, and price of the material is firmly established, and the profits in excess of a liberal increase upon pre-war prices are diverted into the public purse and are shared between the Governments concerned. Fine and medium wools are grown elsewhere within the Empire, notably at the Cape, with some in Canada and the Falkland Islands; but even if these were not acquired an effective hold of the Imperial wool resources would have been taken. The South American clip is the sole large outside supply of good wool. The United States and Russian clips are normally absorbed in local consumption, and the coarse wools of Asia stand on a footing of their own.

Control and its Inconveniences.—State control is not without practical inconveniences, several of which have been felt by those handling home-grown wools under Government supervision. Delays increase pending the appointment and satisfaction of officials, much redundant book-keeping has to be performed, uncertainties prevail and points of friction arise in carrying out the formal instructions. The distribution does not get itself done in a swifter, smoother, and more accomplished manner than hitherto, even though the officers selected are practical men of the trade, and numerous parties are left with a sense of grievance. All this was of inferior account so long as the difficulties were confined to a relatively small part of the supplies; but it would be decidedly unfortunate if the troubles were transferred to the main body of the wool business. The industrial misgivings will not disappear until the Colonial wool is coming forward punctually and freely, and until minds are relieved on the subject of contracts which have been entered into in oblivion of the new control.

Costly Cotton.—The control exerted over wool prices is obviously related to the fact that the Government, on account of itself and partners, is the principal purchaser of manufactured woollens and a buyer of probably 100 million yards a year. Much debated measures have been taken also to moderate the prices of such raw jute as is required for official contracts, and the State has its thumb upon the price of flax. Cotton, which is not to any great extent produced in British countries, has been advancing wildly, until Middling American is some three times the price of the early days of the war, and Egyptian is over 22*d.* per lb. These movements have made all more cheaply bought cotton more saleable, and have contributed to the profits of working, but they bode trouble in the end. Efforts to put down speculation in Egyptian cotton have been made in the Liverpool market, and suggestions are heard of the desirability of official intervention to limit cotton prices all round. The Board of Trade has unquestionably powers under the Defence of the Realm Act to interfere in other markets than foodstuffs, but in two salient respects the case of cotton differs from that of wool and jute.

Scientific Progress.—To judge from current discussion, there remain those who find it impossible to imagine how material improvements in existent practice can be wrought. Close application to scientific research will perhaps show the way, and it is satisfactory to know that the preliminaries to new research are quietly continuing. Definite proposals are being drawn up, and their object is to improve understanding of the changes which take place in course of the processes to which goods are subjected. Given more knowledge, it is always possible that more expedients can be used, and textile practice bristles with actions which are only imperfectly apprehended. There are two schools of advocates of scientific investigation; one loud in its promises and eager to gain publicity for its operations, the other firm in its refusals to speak of cash returns, and content to asseverate that any advance that can be made must directly or indirectly be of benefit to everyone. The times are not propitious to research at present for the assistants are otherwise employed, but it is well assured that tasks and salaries will be found for them.

Some Deficiencies.—Manufacturers are not uniformly satisfied with the pitch of mechanical and technical perfection at which they have arrived. A maker of carpets observes that nobody has yet discovered how to make a power-woven Axminster carpet without losing about 25 per cent. of the woollen yarn used as weft. A principal cause of loss is that certain bobbins carrying the weft become exhausted before others, and although it is not impossible to piece together the short lengths remaining, it soon ceases to be profitable to do so, and the material accordingly goes to waste. Then it is represented that a trade which engaged really inventive people would have found a means of obtaining in Wilton-pile the same liberty of pattern and colour as exists in weaving Axminsters. It is pointed out that in weaving Brussels loop-pile, for every one thread brought to the surface four threads of good worsted must pass underneath and serve no purpose that much cheaper material would not fulfil. Then it is urged that the English have still much to learn in making the most of relatively little material. They have not the art of making 1 lb. of wool used for pile present approximately the same appearance as 1½ lb. The removal of these hindrances is not thought easy, but it is held that they ought to be removed.

Applications of Art.—The original designer of textile fabrics was of course a weaver, and tradition tells of hand-loom weavers who climbed to affluence upon the excellence of their own designs. Young designers trained in the mill and technical school get practice in weaving and learn the limitations of their medium. The possibly more artistic outsider, who is moved to submit sketches from time to time, knows less of these cramping influences, and offer effects which cannot be reproduced. Exasperation follows, accompanied by reflections upon the utility of art schools, and the tension is not necessarily relieved by the art-master's assurance that it is a good deal easier to learn technique than to learn to draw. The subject of art-training is eclipsed at present by that of scientific training and research, although it deserves attention. To an unworthy extent the home market has depended upon German and Austrian looms for figured tapestry goods, not necessarily of the most artistic. In lightness and freshness of taste, England has remained consistently behind France, with the result that French manufacturers have earned the wages of their ability in getting more money for an equal outlay in processes and materials. The facts are plain, and it is to be suspected that English firms experimenting in elaborate woven patterns have been deterred by failures which more insight and originality would have converted into successes. In any event, there is more room for brocade and tapestry weaving and for the production of fancy pile fabrics used as trimmings. More looms are being brought into those classes of trade, and their future is at least as much a matter of art as of success.

Gabardine Cloths.—The modern gabardine cloth has little enough relation to the fabrics out of which Jewish or monkish gabardines were made. A gabardine in the current meaning is a raincoat, and cloths suitable for such coats are gabardine cloths. Goods similar in kind were found useful for costumes and dresses, and sell largely, whether under the full name or under the unlovely contraction "gab." cloth. The name was registered as a trade-mark years ago in connection with linen or hempen fabrics, and the veering of its use round to fine, smooth-faced worsteds, cottons and union cloths often dyed to delicate shades, makes an interesting example of inversion. The word has hardly got a definite meaning left, and serves to denote broadly a fashionable type of fabric. Hitherto its use has been more or less by stealth, under menace of an eminent firm of coatmakers who have, however, now abandoned their claim to its exclusive possession.

OBITUARY.

Sir Hiram Stevens Maxim.—Sir Hiram Maxim, who was born at Sangerville, Maine, U.S.A., in 1840, died on November 24th at Streatham. It is really hardly too much to say of him that he was the greatest mechanical genius of his time, and not only was he a most

skilful and accomplished mechanic, but he was gifted with an inventive ingenuity which spread over a very large range of subjects. How wide this range was is well exemplified in his recent autobiography, and cannot be better summed up than it was in the obituary notice in the *Times*:—"One of his youthful efforts was an improved mouse-trap; he did a good deal with automatic gas-generating plants for domestic and other purposes; he invented an automatic sprinkling apparatus for extinguishing fires, automatic steam-pumping engines for supplying houses with water, feed-water heaters, steam and vacuum pumps, engine governors, gas motors, and many other things." There seemed to be almost no purely mechanical problem which he was not capable of solving, and the problems he actually did solve were, as shown by the above extract, numerous and varied.

He will go down to posterity as the inventor of the Maxim gun, which he described in 1885, at the first meeting of the Society he appears to have attended, when he took part in the discussion on a paper upon "The Evolution of Machines," by Professor Hele-Shaw. He had become a member of the Society in 1883, two years after he came to England in 1881. The history of this invention is given not only in his own biography, but has been recalled in many of the obituary notices published in the newspapers since his death. Many who are still alive will remember a visit to the cellar in Hatton Garden, where the gun was fired down a small tubular range dug out below the street. It was also exhibited at the Inventions Exhibition in 1885, though no publication was then made of the fact that the upper part of the heap of sand into which the gun was fired was gradually shaken down by the repeated concussions, and allowed the bullets to pass through into the adjoining gallery, where fortunately they did no greater harm than the destruction of the upper portion of a glass case. The incident, however, led to a cessation of the gun being shown in action.

His next most important invention, though less successful, probably took up more of his attention, and involved an expenditure of more of his money—the development of the aeroplane. His flying machine (which however never flew) was fully described in a paper which he read here in November, 1894, when Sir Richard Webster (afterwards Lord Alverstone) was in the chair. As has been recently recalled, the experimental machine ran upon a track of rails, each rail having above it a duplicate inverted rail, and the utmost the apparatus ever did was to leave the supporting rails and reach the rails above by which it was held down, without actually resting on any support, until by an unfortunate accident the machine was partly wrecked.

Sir Hiram's last visit to the Society—or, at all events, his last public appearance here—was at the reading of Mr. Eric Stuart Bruce's paper on "Mechanical Flight" in 1908, when he made a long and important speech in the discussion, giving some account of his own experiments, dealing fully with the Wright machine, and anticipating to no small extent the course of development and the actual results which have been attained at the present time.

Space would hardly suffice for even a brief reference to his many other inventions. It should not, however, be forgotten that he was one of the earliest to produce a successful incandescent carbon lamp by his invention of depositing carbon on the filament by heating it in a hydrocarbon atmosphere, with the result of producing a more uniform and stronger filament.

For the latter portion of his life he resided permanently in England, and he became a naturalised British subject. It was in 1901 that he received his knighthood.

NOTES ON BOOKS.

CARDS AND CALENDARS. The Medici Society. London, 1916.

In the spring of the present year an exhibition of British Industries was held at the Albert and Victoria Museum. Amongst other exhibits the Medici Society showed some post cards, which were favourably commented on in an "Arts and Crafts" article in the *Journal* last March (p. 378). These "Old Master" post cards were reproductions in colour of a number of well-known pictures, and were said to be "in an altogether different category from the ordinary German coloured post cards . . . highly coloured daubs caricaturing the originals." The opinion was expressed that they were inclined to "err rather on the side of sombreness," and that they were not quite so good as the early productions of a German firm in Milan. This brought out a very interesting letter from Mr. Philip Lee-Warner, which gave an account of the early successes of Hans Hoesch, the artist of the Milan cards mentioned, and his later failures, as well as of Mr. Lee-Warner's own dealings with him. He was a collotype printer, who seemed to have possessed a certain amount of genius, but to have been sadly lacking in other desirable qualities.

Mr. Lee-Warner has now sent some charming specimens of his firm's works, post cards, Christmas cards and calendars, and they certainly show on a small scale the characteristics which have gained for the larger productions of the Medici Society a deserved reputation.

The specimens sent include calendars with reproductions from Raphael, Botticelli, Van

Dyke and other masters; Christmas cards, many of which are from Old Masters, and others are new, and a number of post cards, Venetian and Egyptian drawings in watercolour by Mr. Reginald Barrett. The Venetian cards are reproductions of the very beautiful illustrations contributed by Mr. Barrett to a book on Venice by Miss de Selincourt (Mrs. Zoete) and Miss Henderson, published ten years ago. They are slightly cut down, to bring them into the limits of a post card, but are not reduced. Naturally some of them suffer by the limitation of size, but in other respects the mechanical work of reproduction is as finely done as in the admirable illustrations in the book, and no higher commendation need be desired.

GENERAL NOTES.

SIR WILLIAM WHITE MEMORIAL.—The Committee which was formed with the object of commemorating the late Sir William White's services to the nation in the development of engineering science, and more particularly of naval architecture, has now completed its task. A sum of £3,197 14*s*. 8*d*. was raised by private subscriptions, and this amount has been expended as follows: (1) The provision of a fund for providing a Post Graduate Research Scholarship in Naval Architecture of over £100 per annum, tenable for two years; (2) the erection of a Memorial Panel; (3) a donation of one hundred guineas to the Westminster Hospital. The Memorial Panel has been erected in the entrance hall of the Institution of Civil Engineers. The Research Scholarship Fund has been made over to the Council of the Institution of Naval Architects, who will administer the fund and award the scholarship. The latter is to be known as the "Sir William White Research Scholarship in Naval Architecture."

SURGICAL CATGUT INDUSTRY IN KWANGTUNG.—According to a report by the United States Consul-General in Hong-Kong, there is a considerable quantity of catgut suitable for surgical use produced in South China, some of which finds its way to the United States. The gut is prepared chiefly in Kwangtung Province, and is manufactured from certain high-grade qualities of Hunan silk. It is made usually in two qualities, rough and smooth, and in different-sized strands. The industry depends to some extent upon the nature of the various crops of silk. For example, one factory finds that during the first two months of the season it can turn out only about 40 lb. of each quality of the gut, while in other months it can produce 45 lb. of each. The two principal qualities now sold are quoted at about 22*s*. per lb. c.i.f. United States port, the price varying with silver exchange.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

DECEMBER 6. — C. M. WHITTAKER, B.Sc., "The Coal-Tar Colour Industry." SIR WILLIAM A. TILDEN, D.Sc., LL.D., F.R.S., will preside.

DECEMBER 13. — H. WILSON FOX, "The Development of Imperial Resources."

DECEMBER 20 (at 4 p.m.).—A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 14. — JOHN AITON TODD, B.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it." The RIGHT HON. LORD EMMOTT, P.C., G.C.M.G., will preside.

Dates to be hereafter announced:—

LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

OCTAVIUS C. BEALE, "British Arts and Crafts after the War."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel."

SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

ROBERT FORTESCUE FOX, M.D., "British and Foreign Spas."

MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France."

HORACE M. THORNTON, M.I.Mech.E., "The Industrial Uses of Coal Gas."

W. A. M. GOODE, Hon. Secretary, National Committee for Relief in Belgium, "Relief Work in Belgium."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

January 18, February 15, March 15, April 19, May 17.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

January 30, February 27, March 27, May 1.

HOWARD LECTURES.

Monday afternoons, at 5 p.m.:—

JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." Three Lectures.

LECTURE II.—DECEMBER 4.—Recent developments in knowledge of composition of coal—Coal as a heating agent—As source of power—For domestic heating, etc.—The by-products from coal distillation, their relation to industry, and particularly as raw materials for munitions of war.

LECTURE III.—DECEMBER 11.—Directions in which economy may be realised—Economy in production—The utilisation of small and low-grade coal—Improvements by suitable preparation for market—Economy in use—By-product recovery—Economies possible from centralised systems of power generation: from extended use of carbonised coal, including gas—Low temperature carbonising schemes.

WILLIAM RIPPER, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications." Two Lectures.

January 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Howard Lecture.) Professor J. S. S. Brame, "Coal and its Economic Utilisation." (Lecture II.)

Farmers' Club, 2, Whitehall-court, Whitehall-place, S.W., 6 p.m. Annual General Meeting.

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

China Society, Caxton Hall, Westminster, S.W., 3.30 p.m. Rev. G. C. Martin, "China in English Literature."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. Mr. I. B. Hobsbaum, "The Production of Nitrate of Soda in Chile."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. R. Farrer, "The Kansu Marches of Tibet."

TUESDAY, DECEMBER 5...Swiney Lectures, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Professor J. S. Flett, "The Mineral Resources of Europe." (Lecture X.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Discussion on paper by Mr. J. B. Ball, "Keadby Bridge." 2. Mr. P. M. Crosthwaite, "Experiments on Earth-Pressures."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. R. C. Bayne, "Stained Glass and its Limitations."

Photographic Society, 35, Russell-square, W.C., 7 p.m.

WEDNESDAY, DECEMBER 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. C. M. Whittaker, "The Coal-Tar Colour Industry."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. C. A. Mitchell, "Copying Ink Pencils and the Examination of their Pigment in Writing." 2. Mr. E. R. Bolton and Miss D. G. Hewer, "Brazilian Oil Seeds."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Dr. R. Piccoli, "Rhythm in English and Italian Poetry."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Dr. F. Oswald and Mr. T. D. Pryce, "Roman Provincial Terra Sigillata, its Evolution and Chronology."

THURSDAY, DECEMBER 7...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. A. C. Chapman, "Spinacidene: a new hydrocarbon from certain fish liver oils." 2. Messrs. C. S. Gibson, J. L. Simonsen and M. G. Rau, "The nitration of 2-acetylamino-3:4-dimethoxy benzoic acid and 3-acetylamino-1:2-dimethoxy benzene."

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Professor W. C. F. Anderson, "Travel Notes in Macedonia."

FRIDAY, DECEMBER 8...Malacological Society, Burlington House, W., 7 p.m. 1. Dr. J. C. Melvill, "A Revision of the species of the Family Pleurotomidæ occurring in the Persian Gulf, Gulf of Oman, and Arabian Sea." 2. Messrs. A. S. Kennard and B. B. Woodward, "On the occurrence in England of *Helicella neglecta*, with notes on the anatomy by Dr. A. E. Boycott, and the radula by the Rev. E. W. Bowell." 3. Messrs. A. S. Kennard and B. B. Woodward, "On the occurrence of *Eulota fruticum* in a living state in Kent."

Shakespeare Association, King's College, Strand, W.C., 5 p.m. Dr. H. B. Wheatley, "The Players' Obligation to Shakespeare and Shakespeare's Obligation to the Players."

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FRIDAY, DECEMBER 8, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 11th, at 5 p.m. (Howard Lecture.) JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." (Lecture III.)

WEDNESDAY, DECEMBER 13th, at 4.30 p.m. (Ordinary Meeting.) H. WILSON FOX, "The Development of Imperial Resources." The RIGHT HON. THE EARL OF SELBORNE, K.G., G.C.M.G., D.C.L , LL.D., will preside.

THURSDAY, DECEMBER 14th, at 4.30 p.m. (Indian Section.) JOHN AITON TODD, B.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it." The RIGHT HON. LORD EMMOTT, P.C., G.C.M.G., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

HOWARD LECTURE.

On Monday afternoon, December 4th, Mr. JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, delivered the second lecture of his course on "Coal and its Economic Utilisation."

The lectures will be published in the *Journal* during the Christmas recess.

CANTOR LECTURES.

The Cantor Lectures on "Vibrations, Waves and Resonance," by J. Erskine Murray, D.Sc., F.R.S.E., M.I.E.E., have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Lectures which have been published separately, and are still on sale, can also be obtained on application.

JUVENILE LECTURES.

A Member of the Council, Mr. Alan A. Campbell Swinton, F.R.S., has kindly undertaken to deliver the Juvenile Lectures this year on "Electricity and its Applications." The lectures will be delivered on Wednesdays, January 3rd and 10th, at 3 p.m. They will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

"OWEN JONES" PRIZES.

Competitions, under the terms of this Trust, have been held annually from 1878 to 1915 in connection with the National Competition of the Board of Education. This competition not having been held in 1916, the prizes were not awarded.

The Council are now prepared to offer six prizes for Designs for Textiles.

Each prize will consist of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

The designs should be suitable for:—(1) upholstery, including curtains, coverlets, etc.; (2) costume and costume accessories, such as bags and purses; (3) carpets and rugs: (4) tapestry; (5) printed, dyed, and stencilled fabrics; (6) lace and embroidery.

This classification, however, is not exclusive, and designs intended for any textile application not specified will be admitted.

The competition will be limited to students of Schools of Art. No competitor may send in

more than a single design in each of the above classes, but that design may be accompanied by one or two illustrative sketches if necessary. If desired, a sample of finished work executed from the design may be submitted with or in substitution for the original drawing.

Each design must be accompanied by a statement of the intended material (*e.g.* silk, cotton, linen, wool, etc.), the process of manufacture (*e.g.* weaving, lace-making, printing, painting, embroidering), etc., and the contemplated use of the finished material.

Competing designs must be approved by the Master or other authority of the student's school, who must also certify that the design is the work of the student sending it in, and that it has been executed since the date of the last competition. No candidate who has already received an Owen Jones Prize can take part in the competition.

Competing designs must be sent, carriage paid, and labelled "Owen Jones Prize Competition" on the outside, to The Director and Secretary, Victoria and Albert Museum, South Kensington, S.W., between June 25th and June 30th, 1917. They may be delivered by hand on any one of the three days ending June 29th.

The sender must also notify the Secretary of the Royal Society of Arts by post that the design has been sent in, and must enclose stamps or P.O.O. for the return carriage.

No special conditions are laid down as to the size or character of the drawings sent in.

The awards will be made by the Council of the Royal Society of Arts on the recommendation of judges appointed by them.

The Council reserves the right of withholding any or all of the prizes offered, and they will be the sole judges in each individual case of the qualifications of a competitor to receive an award.

All possible care will be taken of the designs, but the Council accept no responsibility for injury or loss.

HENRY TRUEMAN WOOD, *Secretary*.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 6th, 1916; SIR WILLIAM A. TILDEN, D.Sc., Sc.D., LL.D., F.R.S., F.C.S., F.I.C., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Baker, George Percival, Ivydene, Cold Blow, Bexley, Kent.

Heap, Arthur Cecil, Vickers House, Broadway, Westminster, S.W.

Knight, Berkeley, Bradley, Overton Drive, Wanstead, Essex.

Wagner, Orlando Henry, M.A., 90, Queen's-gate, S.W.

The following candidates were balloted for and duly elected Fellows of the Society:—

Chrimes, Charles, Holmcroft, Wilbury Villas, Hove, Sussex.

Hansard, George Albert, B.Sc., LL.M., Auckland, New Zealand.

Lindsay, Stuart Currie, P.O. Box 880 Victoria, British Columbia, Canada.

THE CHAIRMAN said that Mr. Whittaker, the author of the paper, was, by his official connection with British Dyes, Ltd., particularly qualified to speak on the very important matter of the British Coal-tar Colour Industry. The meeting-hall of the Royal Society of Arts was historical in connection with the question of coal-tar colours, for it was there, about fifty years ago, that Perkin delivered his famous Cantor Lectures, in which he gave an account of his discovery of mauve and the colours which immediately followed. The Society had also had since then a good many communications, and most of them, especially those by the late Professor Meldola, contained very serious words of warning to the country as to the serious peril of the textile industries. Since Perkin's first discovery of the coal-tar colours a great many others had been discovered by English chemists, and he personally remembered the magnificent display of crystallised magenta and other things shown in the 1862 Exhibition. He also remembered the talk there was in the early eighties of the enormous dividends that were being paid by Messrs. Simpson, Moore and Nicholson. Everybody now knew how, on the outbreak of war, we were dependent upon Germany for the dyes required by the textile industries, due to the fact that Germany forty years ago succeeded in gradually withdrawing the whole of the industry of making colours from this country. Various reasons had been assigned for this state of affairs, Meldola and others held that considerable blame was attached to the universities of this country for not encouraging the cultivation of the study of organic chemistry. Our failure had also been attributed to indifference on the part of British manufacturers and their neglect of science. Something had also been said about the want of industrial alcohol, and others had pointed to the Patent Laws. All these things might have contributed to a certain extent to the loss of this very important industry, but his own belief was that the various reasons he had set out were only signs

and indications of a much deeper kind of disease. The fact of the matter was that the people to blame in the matter were the British public themselves. In this country, the ignorance as to what science was, and the indifference as to what it did, were notorious, but none the less scandalous. Similarly, the ignorance of the educated British public about scientific men was extraordinary. Only the other day he had been speaking to a highly educated lady, the wife of a judge, and Faraday's name was mentioned. "Oh," said the lady, "Faraday, did not he invent some sort of scale?" She was thinking of Fahrenheit. That was only an illustration of the ignorance of educated people, and particularly those who had been brought up at Oxford. Mention Faraday's name or the name of any of the great scientific people of the past and in most cases you would get no response. It showed that Oxford and Cambridge did not choose to cultivate organic chemistry, and it showed also that the manufacturers of this country had been largely indifferent to the use of science, because so many of them had been brought up in the public schools under the influence of an antiquated and mediæval system of education.

The paper read was—

THE BRITISH COAL-TAR COLOUR INDUSTRY AND ITS DIFFICULTIES IN TIME OF WAR.

By C. M. Whittaker, B.Sc.

When your Secretary honoured me with an invitation to give a paper on the above subject before your Society he realised that such a paper must necessarily contain a certain amount of repetition of matters already freely discussed: such being the case, there is no need for me to apologise for any such repetitions which are necessary in an adequate treatment of the above subject. I have given two similar lectures previously this year, and after each I have been assailed in certain quarters for not answering criticisms passed on British Dyes, Ltd. I therefore wish to make it perfectly clear at the outset that I am not here as an apologist for British Dyes, Ltd., but simply by invitation to give a paper on the coal-tar colour industry, with which I have been intimately connected for the last seventeen years—would that some of those who have discussed this industry had had the same experience! I shall be pleased to answer to the best of my ability any points which may arise in the subsequent discussion, but I must respectfully refuse to answer any questions on the policy of British Dyes, Ltd.

In giving a paper on the British coal-tar colour industry, it is always necessary to explain at the outset that the present national circumstances prevent one entering into details which would be most interesting and illustrative of the present situation. These facts, which may not at present be given, will no doubt be given in due course, when they will redound to the credit of the British industry.

The British industry, founded by the discovery of Sir William Perkin in 1856, experienced a period of great prosperity in its early days, which was followed by a decline for a number of reasons, one of which, in my opinion, was that money was so easily made in the early days that the owners were content to rest on their oars and enjoy the fortunes they had secured. Though the coal-tar colour industry had languished, it had never actually become extinct. It may, however, be asserted that the British industry had sunk to its lowest depths about the years 1898–1900; but from then onward it commenced to recover, till in 1915 its competition was being increasingly felt by the German firms, which, just previous to the war, were subjecting the British firms to a severe price-cutting campaign because the British competition in sulphur and direct cotton blacks was reducing to complete nullity the German conventions in those two classes of colours. This improvement had been brought about by enlightened management, which had gradually and unobtrusively been modernising their works and their methods. Had not this revival taken place the task of building up an industry on a national scale would have been made infinitely more difficult, whilst the panic in the dyeing trades at the outbreak of war would have been gravely aggravated and would in all probability have jeopardised the dyeing of the clothing equipment required by the military authorities. The British firms were a considerable national asset at the outbreak of war; had these firms with their trained staffs and experience not been available, it would have gone much harder with colour consumers. The fact that a private firm like Read Holliday & Sons, Ltd., were in a position to pay a dividend of 10 per cent. for the five years previous to the war, when they faced, unaided, the full weight of the German competition, shows that it was possible for a British firm to make a successful fight against the Germans. It is a favourable omen which is consistently ignored by those critics who are untiring in their gloomy forecasts of failure for the efforts presently being made in Great Britain—professional whimperers, as your Chairman termed them the other day.

I wish to take this opportunity of destroying

some of the fallacies concerning British firms which have too long been current and which still persist in some quarters. For the last fifteen years I have been in charge of the experimental dyehouse of Read Holliday & Sons, Ltd., now merged in British Dyes, Ltd. It was part of my duty to supervise the matching of patterns sent in by customers, to prepare pattern cards and circulars, and to carry out what has been termed "expert" work in the way of visiting customers' dyehouses when desired. During that time 50,000 patterns and samples have passed through the firm's books, and not a single pattern was ever charged for, yet I have heard it definitely stated during the last three months that one of the greatest mistakes the pre-war British firms made was to charge for pattern matching, whilst the German firms matched them free. The laboratories of Read Holliday & Sons, Ltd., were always at the free disposal of those in the dyeing trade who wished to make use of them.

The British firms have also been accused of not issuing pattern cards and circulars. Such an accusation was not true, for not only were they issued in a style comparable with those issued by the Germans, but they were also issued in five languages, viz., English, French, Italian, Spanish and German. I have such a card here.

Here I have a manual which was issued in three languages as far back as 1906. Here you have a pocket manual of dyeing instructions which has run to three English editions; here you have this same book in Italian, and here you have it in Japanese. Yet it is less than twelve months since that the British colour firms were asked in an address before a scientific society why they did not use the language, weights and coinage of the foreign countries in which they sold their dyes.

The British are a remarkable people in the way they depreciate the efforts of their own countrymen. The service of the technical experts of the German firms has been repeatedly mentioned without any similar mention of the service of the British firms. Owing to the relative scale of the operations of the Germans as compared with the British firms, the German experts were naturally more numerous. They also had this fact in their favour, that they were often welcomed where the British expert was not welcomed. What progress could be made by a British expert with British firms who told him point-blank, "We would not use your colour if you gave it us"?

People seem to forget that it was Read Holliday & Sons, Ltd., who bought Schutzenberger and Lalande's patent for dyeing indigo in a hydrosulphite vat, and it was Read Holliday's staff of technical men who introduced it to the British indigo dyers, and they who broke down the inevitable prejudice against the something new, because dyers are a very conservative race. You can still find old indigo dyers who talk about the hydrosulphite vat as the "Holliday" vat.

Let this fact at least be remembered, that the hydrosulphite vat for indigo was a French discovery, not a German discovery, and that a British firm—not a German firm—worked the patent in Great Britain.

Since 1901 I and my staff have gone out to scores of places to help to solve difficulties which have arisen in the application of dyestuffs in practice, to make first dyeings of new colours with which the particular dyer was not familiar, and to look into difficulties which in many instances have been in no way connected with the dyeing, but with the previous stages of manufacture, but which were attributed to the dyes, because the fault only became apparent after the dyeing. We have even supplied one of our staff for a fortnight to keep a dyehouse going owing to a dyer having been taken suddenly ill and there being no competent understudy available. Such expert service is being given at the present day. One of the most recent cases to which we went was to find out the cause of the stains on some cloth dyed with a product of British Dyes, Ltd. We proved to the owner's grateful satisfaction that it was his water-supply which was at fault and not the dyestuff. I could go on repeating these cases *ad lib.*, yet it is always the German experts who are mentioned and never the British expert. Truly it is time this fallacy received its quietus.

Now let us examine the position at the outbreak of war as regards the coal-tar colour industry in Great Britain. The principal firms engaged were: The British Alizarine Co., which confined its products to alizarin orange, alizarin red, and alizarin blue—it is largely a co-operative company, as its shares are held for the most part by the large consumers of the above products; the Clayton Aniline Co., which had been absorbed by the Society of Chemical Industry, Basle, though it was located in Great Britain; Levinstein, Ltd., Manchester; Read Holliday & Sons, Ltd., Huddersfield. The two latter were limited companies, the

majority of whose shares were held by the respective families.

The outbreak of war suddenly opened the eyes of the consumers of coal-tar colours in Great Britain to the disconcerting fact that they were largely dependent on Germany for their supplies; then ensued a panic which will ever be remembered by the staffs of the British firms, and which panic subjected them to an almost intolerable strain. The country soon realised that the manufacture of coal-tar colours was a pivot or key industry of the highest importance in which Germany held the dominating position, with Great Britain and Switzerland a long way behind. The realisation of this fact was followed by a deluge of articles and correspondence containing the grossest misstatements which appeared in the newspapers and journals, and were a source of no little amusement to the staffs of the British firms. The relative smallness of the industry in Great Britain was, no doubt, the cause of a great deal of the ignorance displayed. The British firms who were carrying on their industry, conscious of their growing strength and quite inured to the cold shoulder consistently turned to them by scientific societies, were suddenly dragged out into the limelight, and received an amount of attention which was embarrassing.

The cardinal facts of the situation, which were in danger of being lost amidst the controversy, were as follows:—

In 1913 Great Britain imported coal-tar colours to the value of £1,946,224, representing 42 million pounds' weight of colour, of which it was estimated £1,800,000 emanated from Germany. It must not, however, be assumed that all this quantity was consumed in Great Britain, because a considerable quantity of colour is bought here for shipment to India, Australasia, South America and other countries. It is doubtful if much more than half a million of capital was employed in the British industry at the outbreak of war; so there you have the basic fact which faced the industry: how to replace an import of £1,800,000 by firms who did not control more than half a million capital. The task was economically and physically impossible of immediate execution in peace times; it was a hundredfold more impossible in the midst of the greatest war of all time.

I will just deal briefly with some of the commonest mistakes which were made with reference to the German coal-tar colour industry during the discussions.

The most frequent mistake was in regard to the amount of capital which the German firms were supposed to employ in their industry. It was freely stated by Members of Parliament and others that the capital of the German industry was anything from one to two hundred millions. This was, of course, absurd; but such statements did not make any easier the task of those who were endeavouring to establish an adequate British industry. The export value of German coal-tar colours throughout the world was, for the year 1913, £11,349,100; add to this the German home consumption at a generous estimate of £2,000,000, making a total turn-over of £13,349,100. The capital of the German industry was £13,500,000 in 1913, showing that the annual production was approximately equal to the capital. Those who talked about one and two hundred millions capital never stopped to explain how a dividend of from 12 to 25 per cent. could be paid on this capital out of an annual turnover of £13,500,000.

Another point with which I wish to deal is the supposed dependency of Germany on outside countries, particularly Great Britain, for many of the important raw materials of the coal-tar colour industry. Such a state of dependency was no doubt existent in the earlier days of the industry; but the modern coke oven recovery plant has largely altered that state of affairs, as the following official figures for the year 1913 of the imports and exports of important raw materials connected with the German industry show. In considering these figures, I would ask you to bear in mind the fact that Germany's export represents the surplus after all the requirements of her home industry have been satisfied. Starting with benzol, toluol, etc., Germany exported 41,287,000 kilos, and imported only 6,709,600 kilos. These figures do not give much of an opening for crippling tactics. To these figures ought to be added 7,264,700 kilos aniline oil and salts exported by Germany against a negligible import of 156,100 kilos.

In 1913 Germany imported 4,155,200 kilos of carbolic acid, and exported 3,601,700 kilos, an adverse balance of, roughly, 500,000 kilos. It was well known by the tar distillers that the Bayer Co. were making an onslaught on the British market with synthetic carbolic acid, which would have effectively reduced the amount of pure carbolic acid distilled from coal-tar in this country. It must also be remembered that Germany will have made

enormous quantities of synthetic carbolic acid during the war, so that under no combination of circumstances could its industry run short of carbolic acid after its experience of production during the war.

Passing on to naphthalene, Germany imported 5,248,700 kilos, and exported 6,151,110 kilos, in addition to 3,106,400 kilos of naphthols and naphthylamines. Again the balance is in her favour.

I now come to anthracene, of which Germany imported 1,286,100 kilos and exported 277,400 kilos. There the balance is decidedly against her, and it is the only important raw product for colour manufacture in which Germany is deficient. It is the starting-point for alizarin and many of the most important vat colours, which latter have added so much to the prestige of the German firms. It must, however, be remembered that bromine enters largely into the constitution of many vat colours, which gives Germany an effective counter against the possible withholding of anthracene.

I now propose to pass on to the handicaps under which the British coal-tar colour industry has been and is labouring.

The Achilles heel of the British industry was the fact that it had been in the habit of buying many of its intermediate products from the Continent. The result was that at the outbreak of war chemists had to work to replace these intermediate products, and suitable plant had to be erected which absorbed a large amount of energy without increasing the immediate output of colour.

One of the greatest handicaps has been the shortage of chemists. On the outbreak of war I doubt if there were twenty British chemists who had had actual up-to-date experience in the manufacture of coal-tar colours on the commercial scale. Of those who had had experience, some had their energies diverted to the manufacture of explosives to the detriment of coal-tar colour manufacture. It was an inevitable result of the close interrelation between high explosives and coal-tar colours. No complaint is made of the diversion of this energy, but it requires to be stated as one of the definite handicaps of the industry during war time. There was no reservoir of trained chemists from which to draw, so that university trained men of good theoretical knowledge but no practical experience have had to be taken, and naturally some time must elapse before they become adapted to their new conditions. The outbreak of the war, bringing in its train the enormous demand for supplies of high explosives on a scale hitherto not contemplated, illustrated how closely interrelated was the manufacture of coal-tar colours and high explosives.

As everybody is aware, the two high explosives most largely in use are picric acid (or trinitrophenol) and trinitrotoluol. The latter requires similar apparatus to that which is used for making compounds like nitro-benzol, so essential in coal-tar colour manufacture. The engineering trade has been so much occupied in connection with the supply of munitions that it has been difficult to get delivery of the plant for the necessary extensions. For the same reason there has been a shortage of the skilled fitters necessary for the erection of the plant and of men to erect the necessary buildings. In fact, the shortage of labour confronts one at every turn. The increases in the prices of copper and lead, which enter largely into the apparatus used in coal-tar colour manufacture, have also added enormously to the cost of such plant.

The life-blood of the coal-tar colour industry is sulphuric acid, fuming sulphuric acid, and nitric acid. It is the misfortune of colour manufacture that it is impossible to make any colour without the use of nitric and sulphuric acids, the latter being required in various strengths of fuming acid from 70 per cent. down to 20 per cent. SO_3 and D.O.V. These selfsame acids are also indispensable for the manufacture of the two high explosives lyddite and T.N.T. It is a matter which admits of no argument that the demand for acids for the manufacture of high explosives must take priority over their numerous industrial uses. In that fact you have the greatest handicap of the British coal-tar colour industry, because, as is well known by every acid consumer, the supply of acids is nothing like equal to the demand.

Amongst the raw or primary products of the coal-tar colour industry the four most important are benzol, toluol, naphthalene, and anthracene. The distribution of one of these products (viz., toluol) is controlled by the Government. The amount of toluol to be distilled from coal-tar has very definite limits, which are relatively small, so that the reason for this control is obvious. Benzol is the starting-point for the manufacture of synthetic carbolic acid, of which so much is being made at the present time owing to the demand far outstripping the production of carbolic acid distilled from coal-tar. This is being converted into picric acid. Benzol is also being used in large quantities for conversion

into dinitrophenol, from which picric acid is also being manufactured.

Naphthalene and anthracene are free markets. The control of one of the chief primary products is, however, a heavy initial handicap on the output of coal-tar products.

Since the commencement of the war I have been in a specially favoured position to diagnose what is passing in the minds of many colour consumers. One common thought which is very prevalent is, "We can understand you not being able to make some of the German specialities such as indanthrene, alizarin sapphirole, etc., nor do we expect you to do so immediately, but we cannot understand you not being able to supply such old colours as Bismarck brown, benzopurpurine 4B, etc., the constitution and method of manufacture of which have been known for so many years." That is quite a reasonable attitude to adopt, and my paper will, I think, show completely the reason. Such colours are not being made freely at the present time, not through inability of British chemists to manufacture them, but owing to the fact that the necessary products are not available, since they are required for more important processes.

The surplus of benzol and toluol which is set free by the Government after all their requirements for explosives purposes have been met has a preferential call on it before it can be used for general colour manufacture. Next to explosives it is the first duty of the British coal-tar industry to supply the various colours required for the varied equipments of the British, Colonial, and Allied Governments. People outside the trade have very little conception of the numerous colours required by the Government; they vary from mordant brown and sulphur black down to methyl violet for typewriter ribbons and soluble blue for ink for the Stationery Office. The huge demand for khaki uniforms required by the military authorities for the equipment of the troops caused a corresponding demand for mordant yellow, brown and green, blue or black. The demand at the outset for these colours was overwhelming. Mordant yellow was very scarce at the beginning, but the demand for this product has now been more than fully met. Seeing that salicylic acid is a constituent of all mordant yellows, and is in turn derived from carbolic acid, you will readily understand why it was scarce. Mordant brown never caused any difficulties, as the supply was and is more than sufficient to meet all requirements. The supply of mordant green has also been very large. Sulphur yellows, browns, and blacks have also been supplied in very large quantities by the British firms for the cotton equipment of the armies, such as cotton webbing, tropical uniforms, trench capes, ground sheets, mosquito nets, etc. Not only have all the British requirements been met, but large quantities of British-made dyes have been used in Australian, Canadian, Belgian, French, Russian, Italian, and Serbian equipments. I do not give these facts as a handicap on the British industry; rather is it intensely proud of its achievements in this direction under such difficult conditions; but I do put it forward as a definite reason why many colours have not been made which would otherwise have been made had not the energies of the British chemists been so largely occupied in producing explosives and equipment colours.

Now let us examine a few of the products derived from benzol and toluol, which are so important for coal-tar colour manufacture, and you will notice how the whole path is beset with a continuous demand for nitric and sulphuric acids. The primary step in the manufacture of coal-tar colours from benzol is to convert it into nitrobenzol. From nitrobenzol one proceeds to aniline oil and aniline salts, which have numerous uses. They are consumed in large quantities for the production of aniline black on the fibre both in dyeing and calico printing. Aniline oil has always been most extensively made in Great Britain, so that the shortage is not due to any lack of manufacturing experience, but mainly due to shortage of acid. It would be tedious to detail all the uses of aniline oil, but it enters into the manufacture of numerous colours, including acid orange, acid blacks, acid reds, magenta, soluble blues, nigrosines, and indulines, whilst in the form of dimethylaniline it is required for the important basic colours auramine, methyl violet, methylene blue, and malachite green; it has also been largely supplied for munition purposes. p-Nitraniline is a very important derivative of aniline obtained with the aid of the inevitable nitric and sulphuric acids. It is consumed in large quantities for the production of para red by the cotton, calico-printing, and paint trades; whilst it enters largely into the production of many important colours, including blacks; it is also extensively used for coupling on the fibre with suitable direct cotton colours; it is, in addition, the intermediate stage in the production of p-phenylene-diamine, which is used in colour manufacture and by the fur trade for producing blacks and browns on furs. Aniline is also the

starting-point for phenylglycine, which is the primary product for one of the two processes used on the large scale for the production of synthetic indigo.

By the alkaline instead of the acid reduction of nitrobenzol, one arrives at benzidine, which is such an important base for the making of a large number of the popular direct cotton colours, such as blacks, blues, greens, violets, oranges, etc.

Benzidine base has been made in this country in normal times, so that here again the present shortage is not due to the inability of British chemists to manufacture the product, but to inability to get a sufficiency of the necessary materials.

Another important product from benzol is dinitrobenzol, which is the starting-point for m-nitraniline, used in wool colours, and m-phenylenediamine. This latter product is of the utmost value in colour manufacture, and enters into the constitution of numerous important colours, such as mordant browns for wool, which have been used in enormous quantities for military uniforms; sulphur browns for cottons, which have been extensively used in the dyeing of all cotton khaki equipments, such as tropical uniforms, cotton webbing, etc.; it is also required for direct cotton blacks and browns, chrysoidine, and Bismarck brown. You will therefore see that this product is in enormous demand, whilst it must not be forgotten that the production of the equipment colours must take precedence of all other colours. This is the explanation why such common colours as Bismarck brown, chrysoidine, and cotton blacks and browns are in such limited supply—again, not due to the inexperience of British chemists, but to lack of the necessary products.

Another product from benzol which is of the highest importance is dinitrophenol. This product is used in the manufacture of sulphur colours, which are consumed in enormous quantities in peace times, and which have been used so largely in Government equipments. It is fortunate for the cotton trade in particular that the manufacture of this important intermediate product and of sulphur colours was so firmly established in this country prior to the war. I do not think it is an exaggeration to say that sulphur colours have been produced in larger bulk than any other class of colour since the war broke out. The production, huge as it has been, has not been enough to satisfy the legitimate requirements of the trade; but here again the shortage has not been due to lack of experience or plant, but solely to lack of material and labour.

It is fortunate for this country that the manufacture of dinitrophenol was firmly established, because it has been used in an alternative process for the manufacture of picric acid other than direct from phenol. It has, therefore, increased the production of lyddite whilst easing the pressure for synthetic phenol.

The amount of phenol distilled from coal-tar being utterly inadequate for the amount of picric acid required by the authorities, large quantities have had to be made synthetically by caustic fusion of sodium benzenemonosulphonate.

Carbolic acid plays a most important part in colour manufacture, and the shortage of this product has been a very great handicap to the colour industry. Phenol enters directly into many colours, and is one of the components of chrysophenine, the direct cotton yellow which is so largely used and has been so badly missed. Ortho-nitrophenol, which on methylation and alkaline reduction yields dianisidine, is another important derivative of phenol, because dianisidine is the base for cotton sky blue, the absence of which has caused much inconvenience to cotton dyers and has caused famine prices to have been paid for any existing stocks of this colour.

Salicylic acid is another important derivative of phenol, both from a medicinal and a colour point of view. It was not made in this country prior to the war, but its manufacture is now firmly established. It is largely used both medicinally and in the manufacture of colours of the highest importance, including fast chrome blacks, reds, oranges, and yellows, also direct cotton reds and greens. The great shortage of these colours has resulted from the scarcity of this product due to the phenol being required for the manufacture of explosives.

The other derivatives of benzol which I propose to mention are resorcinol, made by the caustic fusion of benzenedisulphonic acid; this product enters into the constitution of many direct cotton colours, and also colours of the rhodamine class; another derivative is chlorbenzol, from which are derived some of the fastest chrome colours for wool extant, amongst which may be mentioned the fast chrome blacks which are fast to potting.

In the manufacture of picric acid for explosives purposes, it is inevitable that some is produced which will not pass the Government specifications. This is liberated by the Government for

the purposes of colour manufacture. For the last fifteen years picric acid has played an important part in colour manufacture.

Toluol is of vital importance as a starting-point for colour manufacture, and the restrictions on its use are responsible for the lack of many colours which are absolutely essential for the dyeing trades. Ortho- and para-nitro-toluol are obtained by direct nitration of toluol. From ortho-nitrotoluol tolidine base is obtained by alkaline reduction, and from it are made many direct cotton colours of large consumption. I will content myself with mentioning one, viz., benzopurpurine 4B. This is the reason why such a common and popular colour is not being made in quantity at the present time. There has been a great dearth of direct cotton yellows in the colour market, but the reason is very simple. In peace times there were three main classes of direct cotton yellows used, viz. :—

1. Chrysophenine, which is made from diamino-stilbenedisulphonic acid (a toluol derivative) coupled with two molecules of phenol and the product ethylated; both the products are required for explosives, hence no chrysophenine;

2. Primuline and the fastest class of direct cotton yellows which are derived from dehydro-thio-p-toluidine—these require p-toluidine;

3. The sun yellow, or stilbene yellow class, which require p-nitrotoluol for their manufacture.

The direct cotton yellows form an excellent example of the handicap imposed on the coal-tar colour industry by the diversion of toluol for explosives manufacture. The last two classes of yellow have always been extensively made in Great Britain; so here again the plant and experience is available but not the material.

Toluol derivatives are also required for the manufacture of sulphur blues and greens; this accounts for the limited supplies available, which are insufficient to meet the legitimate demands of the trade. Toluidine also enters into the manufacture of magenta and safranine which are so largely used in the paper trade amongst others, whilst rosaniline is also required for the manufacture of soluble blue so keenly desired by the shoddy trade. Here, again, the experienced chemists and the plant are available, for all these colours were made in Great Britain in peace times, but the material is now lacking.

Dinitrotoluol leads to m-toluylenediamine, which is so largely used as a developer for diazotised cotton blacks and as a component of direct cotton oranges and blacks.

Among the other derivates of toluol which find extensive application are benzyl chloride, benzaldehyde and ethyl and methyl-benzyl-anilines.

I now pass on to the last mother product with which I propose to deal, viz., Naphthalene.

The uses of naphthalene in colour manufacture are multitudinous, but I only propose to deal with those derivatives of major importance. Naphthalene has no limiting restrictions on its sale like benzol and toluol.

Naphthalene has four primary derivatives, viz., a- and b-naphthylamine and a- and b-naphthol, of which the a-naphthylamine and b-naphthol are the more important. a-Naphthylamine has always been largely made in this country. b-Naphthol used to be made in this country, but was not being manufactured on the outbreak of war. The manufacture has now been resumed, and there are several naphthol plants on various scales working in this country at the present time. a-Naphthylamine is the most important constituent of acid blacks, chrome blacks and sulphoncyanines—all three classes of colour of enormous bulk consumption.

Naphthionic acid, the 1·4-monosulphonic acid of a-naphthylamine is largely used in the production of reds, both acid and direct cotton reds; it enters into the constitution of benzopurpurine 4B. Neville and Winther acid, the 1·4-monosulphonic acid of a-naphthol, is also of considerable importance in the manufacture of acid reds and direct cotton blues.

b-Naphthol is itself used to an enormous extent in what are known as the insoluble azo or ice colours, such as para red, naphthylamine claret, etc., whilst it is also largely used as a developer for the ingrain colours on cotton.

The manufacture of large quantities of naphthalene derivatives is not limited by any shortage of naphthalene, but it is seriously limited by the shortage of sulphuric acid and nitric acids.

The following four acids of the highest importance require fuming acid in their commercial production: H. acid, aminonaphtholdisulphonic acid 1 : 8 : 3 : 6, used in acid blacks, cotton blacks, cotton navies and cotton blues: Chromotrope acid, dihydroxynaphthalenedisulphonic acid 1 : 8 : 3 : 6, used in producing a full range of acid reds of easy levelling powers and good fastness to light which by treatment with bichrome are turned to fast navy blues: Gamma acid, aminonaphtholsulphonic acid

2 : 8 : 6, used very largely in direct cotton colours, notably the "BH" class of blacks; Aminonaphtholdisulphonic acid 1 : 8 : 2 : 4, used in the production of bright blues.

The following important acids do not require fuming acid, but may be made with ordinary sulphuric acid: Phenyl peri acid. Phenyl-a-naphthylamine-sulphonic acid, used for sulphon-cyanines; G salt, b-naphtholdisulphonic acid 2 : 6 : 8, and R salt, b-naphtholdisulphonic acid 2 : 3 : 6, used for scarlets, bordeaux, etc.

I have not touched on anthracene and the alizarin colours, the manufacture of which has not up to now been developed in this country, except the manufacture of alizarin orange, red and blue. Here Nature has imposed an additional handicap on their development, due to the fact that practically all the bromine originates in Germany. Bromine is largely used in this branch of colour manufacture. Vat colours (many of which are anthracene derivatives) are the most modern class of coal-tar colours, and with them may be produced shades of excellent fastness to light, washing and bleaching. It is with this class of colour that the modern guaranteed articles, such as casement curtains, shirts, etc., have been dyed. The colour is guaranteed fast under penalties of replacement if it is not so. The German firms have been rightly proud of these colours, and have been very sceptical of the abilities of British chemists to manufacture them; in fact, one German colour chemist went so far as to say that no British firm would make them in ten years. It is therefore with peculiar pleasure that I show you this afternoon a dyeing of the first vat colour made on a commercial scale by British Dyes, Ltd. I show you a test of chloranthrene blue, which is British made indanthrene blue produced at the Turnbridge Works, Huddersfield, of British Dyes, Ltd. British Dyes, Ltd., is particularly proud of this achievement, and it is only the first of a number of others which will from time to time be put on the market.

I have now finished what must have appeared to many but a mere catalogue. However, I have felt it necessary to show the large number of products which are required in the coal-tar colour industry before a start can be made with colour, and to give an adequate idea of the handicaps which the state of war has imposed on the coal-tar colour industry. The shortage of acid in this country is in course of being rectified, and there is no after effect of the war which may be prophesied with more certainty than that there will be an abundant supply of acids in peace time. British Dyes, Ltd., have now got a large oleum or fuming sulphuric acid plant working successfully as well as a large nitric acid plant.

I now propose to show you what has been done by the British firms in the way of satisfying the requirements of the British and Allied Governments in equipment colours.

Those people who are constantly depreciating the efforts of the British firms seem conveniently to forget what has been accomplished in this direction, and never think of putting it down on the credit side of the account.

You may have seen in the scare press that the dyes being supplied by the British firms were not anything like as good as those of the German firms; but I wish to state most emphatically that khaki uniforms dyed with mordant yellow, brown and green of British manufacture are just as fast to light, exposure and wear as any similar cloth that was previously delivered to the British Government dyed with German colours. The British firms have every reason to be proud of their products for this purpose, and the day when it is necessary to stipulate German colours in British khaki specifications is past.

At the top of the khaki boom, when the military authorities were putting extreme pressure on the manufacturers for delivery, one British firm alone delivered 145,000 lb. weight of khaki wool dyestuffs in the month of December 1915. That was a noteworthy effort of which the firm in question was particularly proud, yet according to our critics we ought to stand in sackcloth and ashes and confess our incompetence. Do you wonder that we refuse to do so? Let people contemplate what the manufacture of that large weight of colour meant; then they will realise what British firms have done, and why some other colours were in short supply. Here you have patterns of the three khaki wool colours which have been so largely supplied for the purpose of dyeing the British khaki.

A large quantity of mordant green was supplied by British firms for dyeing the uniforms of the Italian army. Large quantities of mordant yellow, brown and green of British manufacture are, at the present time, being used in the uniform cloth of the Russian army now being made in Great Britain. I show you the two Russian shades here—a red shade and a green shade. Here you have three colours which have been supplied by British firms in huge quantities for the cotton equipments

required by the authorities, such as tropical uniforms, cotton webbing, ground sheets, mosquito nets, etc. The British army is admittedly the best-equipped army in the field to-day. Are the British colour firms to be denied their share of the credit for this pleasing result? When you see at the various railway stations the soldiers coming home on leave, with the mud of the trenches thick upon them, showing under what severe conditions they have been fighting, do their uniforms and equipment look badly faded? They do not, but they are still a good khaki showing that the British-made colours are not incapable of withstanding the severest war conditions.

Few people have a true conception of the amount of preliminary work which has to be carried out in the manufacture of a coal-tar colour. Here you have a dye-test of a direct cotton black, which in its manufacture has involved twenty-one distinct chemical operations, yet it is known in the dyeing trade as a common black. The amount of preliminary and intermediate work which has to be done before a colour can actually be produced from coal-tar is very large: it is the amount of this preliminary work which makes the progress appear so slow to those people who have no conception of the detail work in colour making.

The future of the British coal-tar colour industry is a fascinating subject, about which every man may speculate, but of which no man may speak with certitude. True to our national character, the scientific pessimists are enjoying themselves preaching national disaster unless their own particular nostrums are adopted. I am unmoved by these predictions. I am old enough to remember the British push-cycle trade being told that the American push-cycle would sweep them out of the market: where is the American push-cycle in Great Britain to-day? The same jeremiads were sung about the British motor trade as compared with the French: does not the British motor to-day stand unsurpassed? Of more recent date, the British aeroplane has been denounced as inefficient, but which aeroplane flies over its enemy's lines the more—the British or the German? Therefore, I am unmoved by the prophets of gloom concerning the coal-tar trade colour. At the outbreak of war predictions of dire disaster were prophesied to the textile trade, owing to the shutting off of German colours. Those predictions have been completely falsified, because what do we actually find? We find the shares of the leading colour-consuming companies in this country actually standing at much higher figures than they were before the war: textile shares are one of the features of the Stock Exchanges. I maintain that the British firms can claim a share in that very satisfactory state of affairs, owing to the way in which they have expanded their supplies. The British firms had not only the future for which to provide, but they had also the immediate shortage with which to deal. Naturally steps had to be taken which would not in normal times have been tolerated, but the successful way in which they dealt with that shortage is reflected in the equipment of the British army, and in the fact that the dyeing trade, instead of sinking in disaster, has never been so prosperous.

The war has opened the eyes of the world to the value of the chemist, who now bids fair to be granted that status which should always have been his. The future is with the trained chemist. Research is now being organised on a scale which has never before been attempted in Great Britain, and British Dyes, Ltd., are happy to know that the director of their research department, in the person of Professor W. H. Perkin, possesses a name of the happiest augury in the coal-tar colour industry.

When I think of the army of research chemists employed in the past by the German firms, I am amazed, not at the results which they have produced, but I am amazed that the results were not much greater. The German firms employed mass tactics with their chemists, just as their General Staff employ mass tactics with their soldiers. Why should not the British chemist do quite as well as the German chemist? He is at last being given a chance to fight on equal terms. The future will show the outcome of that fight. Speaking for my colleagues, we enter the fight with full knowledge of its severity, but with great keenness and every confidence.

Cannot the pessimists draw some cheer from the success of the national efforts in the manufacture of high explosives? We never pretended to be a nation skilled in industrial organic chemistry, but look at the splendid results produced in a short time by British chemists in the matter of high explosives under the organising genius and enthusiasm of Lord Moulton.

If the British consumers are honest in their desire not to buy German dyes again, there are already many dyes on the list which they need never buy from Germany again, and this list will grow rapidly in the near future. The

future of the British coal-tar colour industry depends as much on the good-will of the consumer as on the industry itself. Let sympathy and patience be extended to the industry during these early days of expansion—the task in front of the industry is sufficiently heavy to warrant it.

DISCUSSION.

THE CHAIRMAN (Sir William A. Tilden, D.Sc., Sc.D., LL.D., F.R.S., F.C.S., F.I.C.) said they had listened to something which must be a great encouragement not only to the chemist and the manufacturer, but to the public in general. He himself felt much happier for having heard the paper.

DR. M. O. FORSTER, F.R.S., said the point in the paper as to the importance of the contribution to the colour industry which had been made by British firms before the war needed emphasis, because it was very often lost sight of in the discussion of this subject. If a comparison were made of the condition of the British colour industry before the war with that of the colour industry in other countries, excluding Germany, it would be found that, with the single exception of Switzerland, Great Britain was far and away ahead of all others. France had a colour industry before the war, but it was practically an intermediate assembling industry—*i.e.* the large colour factories which existed in France before the war imported intermediates from Germany and simply assembled them. Consequently, with one or two small exceptions, there could not be said to exist in France any indigenous colour industry. In America the case was similar. There were one or two small factories so far as the home supply of intermediates was concerned, but most of the colours in America were made from German-supplied intermediates. In this country it was true we imported large quantities of intermediates, but there was also a substantial intermediate manufacture here, so that in that respect we were ahead of those other countries, except Switzerland. It was the question of the intermediates which, in his opinion, stood at the root of the whole difficulty. We did not make enough of these intermediates in this country, and the whole energies of the colour manufacturers must be bent towards meeting that difficulty. When it was realised that there were something like eighty or one hundred intermediates of greater or less importance, each one of which often involved six, eight, ten, and sometimes as many as twenty separate chemical operations in its production, some idea would be gained of the extraordinary complexity of this industry. There was one matter he would like to call attention to which had always seemed to him to be one of the blots of the colour industry, and it was the ridiculous confusion in the nomenclature of colours. In the November number of the American *Chemical Engineer* there was an extraordinarily interesting report by Mr. T. H. Norton, describing the census of the American consumption of colours, which had been taken before the war. This was deserving of the attention of everybody who was interested in this matter. It took two years to complete this census, owing to the extraordinary reluctance of the consumers to provide the information. Eventually it was compiled from the sheets of the Customs House officers, showing the imports of the various colours at the different ports, and it was discovered that there were more than five thousand different names of colours. The whole range of colours was not more than eight hundred or a thousand, and there was such a waste of time from the variety of nomenclature that some change was necessary in that respect. Many of the names, it would appear, had been introduced simply to confuse competitors. That, up to a certain point, was a perfectly legitimate motive, but it had also been done to exercise a kind of tyranny over the users, so that the user, once caught, should not escape the clutches of the particular dye-maker. Users did not have the technical knowledge to ascertain what were the colours they were actually using, and they simply took them on the label from the people who supplied them. That practice of confusing the issue by all these different names for the same thing should be abolished, and the confusion of taking the same name and adding to it a number of more or less misleading letters, which simply indicated the degrees of dilution, should also be abolished, because it would be quite easy to give the name of the colour and add after it the percentage of actual colour in the particular sample which was being sold. He hoped that Mr. Whittaker would use his influence in this direction.

MR. W. L. OAKDEN asked if there were any dyes or colours which it would be impossible to manufacture in this country for want of materials, and for which we should have to depend upon Germany. Supposing we could manufacture all colours, did Mr. Whittaker think that some restrictive measures could be taken to prevent Germany dumping their colours on this country after the war?

MR. CHARLES BEDFORD, as a member of a family that had been manufacturing natural colours for a hundred years, said he appreciated the competition which British firms had had to meet during the last thirty years from Germany, not only from the fact that chemical science had been developed there to a very large extent, but also because of the greater attention given to higher education and business training generally. He remembered very well, in 1887, he patented a colour in which the colouring matter of fustic was combined with diazobenzene chloride. It was rather interesting at the time as a combination of natural and artificial colouring matter. That had not been in existence three months before he was called upon by a representative of the Badische Anilin Company asking

for a licence to manufacture. He objected, but was told that so much capital would be brought against him that he would have to grant the licence. The Badische Company manufactured the colour under licence for several years until mordant yellow made its appearance, when the demand declined. There was now little doubt that after the war British colour-makers would be able to take their place in the world's markets and supplant German colours.

Mr. W. F. Leeson said that there were probably very few present besides himself who had heard Perkin describe his discovery of coal-tar colours. It had been a matter of deep regret to him to see the trade slip away to Germany, but he now rejoiced that we were likely to re-establish this great British industry.

Mr. J. Wilson expressed the hope that British colour-makers would adopt a more generous attitude to teaching institutions in the future than they had done in the past. A few years ago, in the institution with which he was connected—a London institution—they endeavoured to start instruction in dyeing. Naturally they wanted samples of dyestuffs, but the response received from British makers was singularly discouraging. On the other hand, German firms sent some 700 or 800 samples, and consequently the students always had before them German dyestuffs. He was glad to say that, so far as Mr. Whittaker's firm was concerned, that attitude was now completely altered; but he hoped British firms generally would be more generous in the future for their own sake, and certainly for the sake of the development of technical science in this country.

The Chairman said Mr. Wilson's experience did not accord with his own, for thirty years ago he had found British firms very willing to help teaching institutions.

Mr. James Swinburne, F.R.S., said it did not follow in the least that because before the war we did not make certain things we were incapable of making them. We made things which we exported, and we must have something in exchange. The fact that on the whole it had paid us best to take dyes as one portion of our exchange did not in the least show that, if necessary, we were not just as able to make dyes as the Germans. We had had to make dyes during the war, and British firms had gone ahead tremendously under every conceivable kind of disadvantage, but the real question was what would be the position after the war of a concern like British Dyes, Ltd.? If we had only dyes to think of in connection with our foreign trade, we could, no doubt, by some fiscal means safeguard the industry, but other things had to be exported; and, taking the larger view, the question was whether British dyes would be able to hold their own against German cheapness after the war. As far as the German chemist was concerned, he was a plodding man, with no sense of proportion and no originality. The British chemist, on the other hand, went at things in a properly balanced kind of way, and he had imagination and new ideas. Consequently, instead of taking up the manufacture of existing colours, as the dye-makers in England were doing now, we should soon see the British chemist inventing better dyes which would replace the German dyes. If we could only get over the difficulties which must occur when the war was over, there was a great future not only for the British chemist, but for the chemical engineer.

Mr. R. E. Oldroyd, speaking as a user, expressed appreciation of the efforts made on their behalf by British Dyes, Ltd. With regard to the large number of names mentioned by Dr. Forster, he must confess to being one of the culprits, and Mr. Whittaker had helped him to put a number of new names on the market. A certain number of colours were produced for his special use, and these were all given new and distinctive names, and that was the reason for so many different markings on the various colours. A previous speaker seemed to be afraid that our manufacturers of colours could not compete in the future, and raised the usual cry that we would have to be protected. He did not think so. If we looked at the trade carefully, we should see that it had all the protection it needed. There was indeed one protection which the dye-maker could rely upon, and that was the support of the English user. He was chairman of a guild of users, and the majority of the members had agreed in future to support British dyes whenever it was possible to get them. In the past it had not always been possible to get them. The other protection the makers now had was the guarantee of the supply of the chief chemicals with which to make their dyes. The Government department concerned in explosives had now made arrangements for chemicals, and the large number of acid plants erected for explosives would be available for the dyeing industry after the war. Moreover, the capital charges on these plants would have been largely written off during the war, and makers should be able to look forward to as cheap chemicals as were obtained by their German competitors. Further than that, the German maker would not be in the same position after the war as he was before. Although the Germans had not the world's supply of bromine, yet they had a monopoly, but there were other chemicals which would balance that. After the war we should be able to keep a hold on the heavier chemicals, which the Germans got to a very great extent from our large makers, and so prevent any monopoly on that side of the industry. At present the dye-maker was suffering because the plants supplying the chemicals for high explosives were the same as those from which dye chemicals came, but after the war those plants

would be available, and then the industry would be much more secure than had hitherto been the case.

Mr. Walter F. Reid called attention to a point not mentioned in the paper, viz., the very large incomes produced to German manufacturers of dyes from synthetic remedies. They were synthetic, undoubtedly, but whether they were remedies was quite another question. At any rate, they had made the civilised world believe they are remedies, but the mortality from taking some of these drugs was growing very rapidly. Nevertheless, their manufacture was a source of great income, and it was a subject we should not lose sight of altogether. One thing that ran throughout the paper was the rather unnecessary apologetic view taken of what the British dye industry had done. He came into contact with a very large number of technical chemists, and he had not heard this disparaging language used very frequently. Whenever it had been used it was by people who had had no experience of the industry. Those who did know had nothing but praise for British chemists, who, without previous experience, had worked out most difficult processes, sometimes with only a patent specification to guide them that was made to mislead in the first instance. One piece of personal experience, however, he had. The dyes used on the uniforms of volunteers were by no means fast, as a glance at a regiment of volunteers showed. He hoped British makers, when they did put these dyes on the market, would give as good as their competitors did previously. As to the number of colours, it was a general supposition that the ladies required a certain number of new shades each year, but he did not think they really wanted them at all. They only bought them because they saw them in the shops and they looked pretty. If the dyers and those who used dyes would agree to limit the number of dyes to, say, one thousand, that would be the best measure of protection against foreign dyes they could possibly have, because a German traveller coming here with patterns of beautiful dyes would not be able to persuade buyers to use them.

Mr. Whittaker, replying first on the question of the number of dye names, said he could not hold out much hope that it would ever be remedied. In most cases they were colours made by many firms, and unless special names were used the firm for whom the order was intended might not get it. For instance, if B. H. black were ordered it would be known that it was to be supplied by Read Holliday & Co.

Dr. Forster said he thought it affected the question of the multiplicity of names. Mr. Whittaker had said that there might be a number of names for a perfectly definite thing which everybody was making. It was not as if it were a proprietary article of which only one firm had the secrets.

Mr. Whittaker, continuing his reply, said the only product for which we would have to depend upon Germany was bromine. At present there were a number of dyes we could not manufacture, but not from want of materials. That would be remedied in time. As regards the attitude of British firms to teaching institutions, the fact that British Dyes, Ltd., had made a grant of £5,000 towards the coal-tar colour department of the Huddersfield Technical College was proof that whatever their faults in the past, they had mended their ways now. Concerning the exchange of products, Mr. Swinburne's argument was true; but it was rather unfortunate when the exchange product was a pivot industry on which the whole of the textile industry depended. As regards the fastness of dyes, he maintained that those supplied for khaki uniforms were equal to anything from Germany.

A hearty vote of thanks was accorded the author at the conclusion of the discussion.

ARTS AND CRAFTS.

Mr. Nelson Dawson's War Memorials.—Mr. Nelson Dawson's little exhibition of Records and Memorials at the Fine Art Society's galleries is interesting from two very different points of view. To begin with, the exhibits are the work of an artist who thoroughly understands his material and whose work has always a certain distinction. But the show in Bond Street has another and a rather more unexpected attraction. In it Mr. Dawson has tried not so much to show what can be done in the way of large and elaborate memorials, as to demonstrate that the smallest wall tablet, so long as it is well designed and has a character of its own, may be a really worthy memorial. This is a point which has had far too little attention paid to it. People in days past have had no appreciation of the value of wall space in our cathedrals and parish churches, and it is high time that the question of the size of memorial slabs and the like received serious attention. It is only men and women of real and outstanding distinction who ought to be commemorated in public places by large memorials. Mr. Nelson Dawson's idea of making a tablet some 12 in. or 18 in. high, either wrought entirely in metal (with or without some enamel on it) or with the metal ornamentation mounted on an appropriate wooden slab, is one which has a great deal to commend it. His selection of heraldic devices as his principal *motifs* has, further, led to very happy results. His whole handling of his subject suggests inevitably the question of the wider treatment of commemorative tablets in schools, colleges and other institutions in which some record is wanted of those who have served and fallen in the war. A mere list of names is not always

sufficient. It is a rather bald acknowledgment after all, except in the very rare cases where the lettering itself is a work of art. A number of small memorial tablets dotted casually about a wall have that spotty and altogether unsatisfactory effect with which we are all so familiar in churches and other places. Mr. Dawson's small tablets, treated as they all are in much the same manner, dependent on shields and coats of arms for their main interest, carry us almost before we are aware to the thought of a whole series of such designs, all of the same type and yet differing from each other as the work of any true artist needs must, serving to decorate a hall or chapel, either in the form of a kind of dado line carried right round, or as a carefully planned and considered group at the end of the room or at some central point.

The "Englishwoman" Exhibition of Arts and Handicrafts.—Exhibitions of Arts and Crafts devoted entirely to women's work are not, as a rule, very satisfying affairs from the point of view of art. There is, for the most part, an air of amateurishness about them which tends to make the scoffer rate women's achievements far below their real standard. The *Englishwoman* Exhibition of Arts and Handicrafts, held this year for the second time at the Central Hall, Westminster, cannot be said to have been altogether free from the defects which characterise other undertakings of a somewhat similar type; but it was, on the whole, a very interesting show. Though rather weak in some directions, in others it proved itself very strong indeed. This is the more noteworthy as so much of the work on view at Burlington House at the same time was executed by women that it would not have been surprising had the level at another exhibition held contemporaneously fallen below the normal standard. It is true that some of the more important branches of women's art work were not very adequately represented at the Central Hall: the metalwork, for instance, was unimportant, and the jewellery, compared with the best work at the Arts and Crafts, was very far behind. Moreover, there were a certain (not a very large) number of stalls devoted to what can only be called the fripperies and eccentricities of artistic craftwork. On the other hand, the exhibits of weaving, lace-making, embroidery, toy-making, etc., if not very remarkable individually, revealed collectively an amount of honest, persevering and intelligent work by a number of women which is full of hope and promise for the future. The colour of much of the weaving was particularly good, and some of the industries (notably Shottery) are weaving patterns in colour at the ends of cloths and towels which suggest old Italian needlework. The embroidery was often skilfully arranged to be suitable for dress decoration; for instance, the overalls of various shapes and sizes, with just enough simple stitchery to give them individuality, were a very happy idea. The Celtic designs, again, carried out in tasteful colours by the Dun Emer Guild, were as attractive as ever. Amongst the toys, the most successful were perhaps the wooden animals, farms, Noah's arks and the like, which made one wonder how we had ever put up with the atrocities which were the invariable rule before the war. There was some good illumination and also some parchments decorated more or less in Italian fashion which were less satisfactory. On the whole, the works shown reached a really high level, and the exhibition left one with the impression that women hand-workers are advancing both in technique and in taste.

OBITUARY.

COLONEL THOMAS EDGAR JOBLING.—Colonel T. E. Jobling, of Bebside Hall, near Blyth, died, after a brief illness, on October 7th.

Colonel Jobling was the managing owner of the Choppington and Bebside Coal Company, and the Vice-President of the Northumberland Coalowners' Association. He was an Alderman of the County Council, and for many years was Chairman of the Elementary sub-committee of the Education Authority, but resigned the position about twelve months ago. He was elected a member on the formation of the County Council, and took a considerable part in the administrative work of that body. He was Chairman of the old Cowpen Local Board, and Chairman of the Cowpen School Board, holding that position until the dissolution of those authorities. He had an almost life-long connection with the Volunteer movement, having joined the Tynemouth Artillery Volunteers when quite a young man. He identified himself with the voluntary recruiting campaign after the outbreak of war, and latterly represented the military authorities at the local tribunal. He was chairman of the Blyth bench of magistrates.

He was elected a life member of the Royal Society of Arts in 1885.

GENERAL NOTES.

TECHNOLOGICAL EXAMINATIONS.—The report on the examinations for the current year of the City and Guilds Institute has just been published. Like all other examining bodies, the Institute has suffered seriously in the numbers of its candidates during the past two years. In 1913-14 there were altogether 23,119 who came up for examination. Last year this number dropped to 15,623, and this year to 8,508. There was also a falling-off in the number of centres: this year there were 316, last year 419, and the year before 467. The record year seems to have been 1910, when 24,508 were

examined at 418 centres. The number of subjects of examination has now reached 79, a considerable development of the 14 which the Society handed over to the Institute in the year 1879.

HARVEST IN WAR ZONE IN FRANCE.—The harvest in the war zone in France, this year, appears to have been a fairly good one, judging from a report made by the military authorities. The production of wheat in the three Departments of the Oise, Somme, and Nord were slightly below the average, whilst that of the Pas-de-Calais, notwithstanding the dearth of hands and difficulties of transport, showed better results than in 1915. The oat crops showed a decided improvement. The prospects of the beet crops, both for sugar-making and for distilling, promise well, and a production above the average may be predicted.

ECONOMY IN BREAD-MAKING.—With the price of wheat still rising, it is interesting to learn that a new process of bread-making, direct from the corn, without the preliminary conversion into flour, is in operation in the municipal bakery at Bergamo (Italy). The wheat, which must be first thoroughly cleaned, is then soaked in hot water for twenty-four hours, more or less, according to its degree of hardness. During this time it commences to germinate and undergo a complete transformation. This pasty mass is next kneaded into dough, yeast is then added, and the whole worked up to the proper consistency, allowed to rise, then formed into loaves, and baked in the oven in the usual manner. Bread made in this way is said to be quite as palatable and far more nourishing than the ordinary wholemeal article, containing as it does all the constituent parts of the wheat. It is claimed, moreover, that a saving of 25 per cent. in the cost of bread-making is effected by this direct process, and at the same time a larger yield from the corn is obtained.

CHEMICAL FILTER PAPER.—In the course of an article on this subject in a recent issue of the *Analyst*, Mr. E. J. Bevan and Mr. W. Bacon state that it is estimated that, prior to the war, 500,000 to 600,000 lb. of filter paper of all grades were imported into this country; at the present time only four English paper-makers are producing filter paper, but excellent qualities of paper are now on the market. For most filtering purposes a paper should possess the character of "softness," and the technical term for this is "bulk," a term defining the relation of the volume of the paper to the volume of the fibre; generally, for a moderately rapid filter paper the bulk should be about 3·5 (fibre = 1). Pinholes sometimes occur in papers of this class and are due to faulty manipulation of the beaten stuff at the mill. Cotton cellulose is preferable to linen (flax) cellulose in the manufacture of high-grade filter papers owing to its low hydrating power and to the fact that it imparts more bulk to a paper. It is difficult to get new waste material for this manufacture, and the source of many of the chemical impurities in the finished paper may be traced back to the raw material. The lime present in filter paper is chiefly derived from the water used in the manufacture; chemical bleaching of the material also contributes to this impurity. Iron and copper are frequently present and sometimes alumina and silica, due to loading of the material with kaolin. Starch and oil are the chief organic impurities in filter paper; both are derived from the raw material, and are for the greater part removed by the alkali treatment and washing.

COTTON MANUFACTURE IN CHINA.—According to the report for 1915 of the Commissioner of Customs at Tientsin, the difficulty experienced in obtaining adequate supplies of cotton piece-goods from abroad has resulted in a considerable stimulus to the manufacture of these goods by local Chinese factories. Factories equipped with modern machinery were erected in several localities under Chinese management and using Chinese labour, foreign experts being engaged to teach the best methods of manufacture and how to make the best use of the machinery. The products of these factories correspond in weight and design to the imported goods, and compete profitably in the open market with similar goods manufactured abroad, the tendency among buyers being apparently in favour of Chinese-made goods in preference to the cheap varieties imported from Japan, or the higher and more expensive grades coming from Europe and America. A group of Chinese merchants has also placed orders in America for the latest spinning machinery, to be used in two new mills for the making of cotton yarn. If these should prove a success, there is no doubt that similar plants will be erected in other parts of North China.

KOREA.—An American, who has recently visited Japan and Korea, sends in a private letter some interesting impressions of Korea, and the progress which the Japanese have made in developing that country. He says: "Japan needs to populate Korea. I spent some weeks there, meeting all sorts of people—Koreans, Japs, British, and Americans. There is only one thing to be said: they are making Korea into a country, with new roads, good hotels, savings banks, electric railways, schools, churches, etc. For the first time Koreans dare to accumulate property, dare to send children to school. The Jap teachers told me the Koreans learned faster than the Japs, evidently having having a real thirst for knowledge. In some of the classes there were pupils of thirty or thirty-five studying and reciting with children

of nine or ten. I visited many schools, some for girls, others for men and boys. It was really an inspiring sight—all these mixed ages working for their education. Imagine this: the best hotel I ever was in, outside of one of the largest cities, was in Seoul. It was built by the Government. Its architecture is excellent. The building materials, white marble, tiles, curtains, etc. (except the chairs, carpets, and window shades), were all Korean. The menu included anything one can get in New York except oysters. Sole, real sole, every day! Drinks! Segars! Certainly, all kinds. The best Havanas at a quarter the price paid in London."

SOCIETY OF ARTS MICROSCOPES.—A correspondent of the *Westminster Gazette* recently drew attention to the large number of microscopes of the Society of Arts pattern which were being offered for sale, second-hand, in a shop on Ludgate Hill. The origin of these instruments is interesting. In 1854 the Society offered two medals, one for a simple and one for a compound microscope, to be supplied at the price of 10*s.* 6*d.* and £3 3*s.* respectively. It was said that at such prices nothing of any practical use could be provided, but Messrs. Field, of Birmingham, produced two excellent instruments at the stipulated prices, and the prizes were awarded to them. The smaller instrument, which is now very familiar, appears to have been then quite novel in construction and design; it was well suited for the examination of botanical and other natural history specimens, and large numbers of it were sold. The larger compound microscope was a thoroughly serviceable instrument, and certainly nothing like it had ever been produced at the price. Public appreciation of it was shown by the fact that by the end of 1861, 1,800 instruments had been sold.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

DECEMBER 13.—H. WILSON FOX, "The Development of Imperial Resources." The RIGHT HON. THE EARL OF SELBORNE, K.G., G.C.M.G., D.C.L., LL.D., will preside.

DECEMBER 20 (at 4 p.m.).—A. C. BENSON C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education." The RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., will preside.

JANUARY 24.—W. A. M. GOODE, Hon. Secretary, National Committee for Relief in Belgium "Relief Work in Belgium."

JANUARY 31.—MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France."

FEBRUARY 7.—ROBERT FORTESCUE FOX, M.D. "The Future of British Spas."

FEBRUARY 14.—LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 14.—JOHN AITON TODD, B.L., Professor of Economics, University College Nottingham, "The World's Cotton Supply and India's Share in it." The RIGHT HON. LORD EMMOTT, P.C., G.C.M.G., will preside.

Dates to be hereafter announced:—

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

OCTAVIUS C. BEALE, "British Arts and Crafts after the War."

COLONEL SIR THOMAS H. HOLDICH, R.E. K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel."

SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

January 18, February 15, March 15, April 19 May 17.

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

January 30, February 27, March 27, May 1

Howard Lectures.

Monday afternoons, at 5 p.m.:—

John S. S. Brame, Professor of Chemistry, Royal Naval College, Greenwich, "Coal and its Economic Utilisation." Three Lectures.

Lecture III.—December 11.—Directions in which economy may be realised—Economy in production—The utilisation of small and low-grade coal—Improvements by suitable preparation for market—Economy in use—By-product recovery—Economies possible from centralised systems of power generation: from extended use of carbonised coal, including gas—Low temperature carbonising schemes.

William Ripper, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

Cantor Lectures.

Monday afternoons, at 4.30 p.m.:—

Professor A. Beresford Pite, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

Aldred Lectures.

Monday afternoons, at 4.30 p.m.:—

Lawrence Weaver, F.S.A., "Memorials and Monuments." Three Lectures.

March 6, 13, 20.

Juvenile Lectures.

Wednesday afternoons, at 3 p.m.:—

Alan A. Campbell Swinton, F.R.S., "Electricity and its Applications." Two Lectures.

January 3, 10.

MEETINGS FOR THE ENSUING WEEK.

Monday, December 11...Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. (Howard Lecture.) Professor J. S. S. Brame, "Coal and its Economic Utilisation." (Lecture III.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. W. St. Clair Tisdale, "The Influence of Christianity upon other Religious Systems." (Gunning Prize Essay.)

Engineers, Society of, at the Geological Society, Burlington House, W., 3 p.m. 1. Professor W. G. Fearnsides, "The Sources of the Minerals required by the Iron and Steel Industries of the United Kingdom." 2. Professor C. G. Cullis, "The Mineral Resources of the British Empire as regards the Production of Non-Ferrous Industrial Metals."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Professor K. J. J. Mackenzie, "Suggestions for the Improvement of Cattle-Breeding in Great Britain."

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Engineers, Junior Institution of, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. Presidential Address by Mr. F. W. Lanchester, "Industrial Engineering: Present Position and Post-War Outlook."

Tuesday, December 12...Cold Storage and Ice Association, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Mr. J. W. Anderson, "Education and Research in the Refrigerating Industry."

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Dr. A. Cowley, "Professor Hrozny's Views on the Hittite Question."

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Sir Walter Raleigh, "The Ordeal of Empire."

Wednesday, December 13...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Mr. H. Wilson Fox, "The Development of Imperial Resources."

Automobile Engineers, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. F. W. Lanchester, "Worm Gear and Worm Gear Mounting."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Dr. Pinches, "Some Texts of the Relph Collection—with Notes on Babylonian Chronology and Genesis xiv."

Japan Society, 20, Hanover-square, W., 3.30 p.m., Mr. R. P. Porter, "My Visits to Japan (1896-1916)."

Thursday, December 14...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Professor J. A. Todd, "The World's Cotton Supply and India's Share in it."

Geographical Society, Kensington-gore, W., 5 p.m. Discussion, to be opened by the Secretary, on "British and Metric Measures in Geographical Work."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Miss I. McClatchie, "Observations on the Root System of *Impatiens Roylei*, Walp." 2. Dr. A. S. Woodward, "On the Teeth of some Palæozoic Sharks." 3. Miss A. J. Davey and Miss M. Gibson, "Sex Distribution in *Myrica Gale*, Linn."

British Academy, in the Theatre, Burlington-gardens, W., 5.15 p.m. (Schweich Lectures.) Professor L. W. King, "Legends of Egypt and Babylon in Relation to Hebrew Tradition." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Ten-minute lecturettes by Members.

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. L. C. Martin, "The Refractometry and Identification of Glass Specimens—especially Lenses." 2. Dr. R. S. Clay, "A Workshop Method of Determining the Refractive Index of a Piece of Glass having one flat Surface."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. R. W. Weightman, "Colonial Telegraphs and Telephones."

Chadwick Public Lecture, at the Surveyor's Institution, Great George-street, S.W., 5.15 p.m. Mr. P. Waterhouse, "Architecture in Relation to Health and Welfare." (Lecture III.)

Friday, December 15...Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, Westminster, S.W., 6 p.m. Mr. R. E. Phillips, "Variable-Speed Gears for Motor Road Vehicles."

Illuminating Engineering Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Address by Mr. L. Gaster on "War Economies in Lighting."

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FRIDAY, DECEMBER 15, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, DECEMBER 20th, at 4 p.m. (Ordinary Meeting.) A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education." The RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., will preside.

[Fellows are requested to note that the hour of the meeting is 4 p.m.]

Further particulars of the Society's meetings will be found at the end of this number.

HOWARD LECTURE.

On Monday afternoon, December 11th, Mr. JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, delivered the third and last lecture of his course on "Coal and its Economic Utilisation."

On the motion of the CHAIRMAN a vote of thanks was accorded to Professor Brame for his interesting course.

The lectures will be published in the *Journal* during the Christmas recess.

COLONIAL SECTION COMMITTEE.

A meeting of the Committee of the Colonial Section was held on Tuesday afternoon, the 12th inst. Present:—

Lord Blyth (Chairman of the Committee), Byron Brenan, C.M.G., Richard Ernest Brounger, Hon. Sir John A. Cockburn, K.C.M.G., Edward R. Davson, Major Edward Humphrey Manisty Leggett, R.E., D.S.O., George Wilson, C.B., with Sir Henry Trueman Wood, Secretary of the Society, and S. Digby, C.I.E., Secretary of the Section.

JUVENILE LECTURES.

A Member of the Council, Mr. Alan A. Campbell Swinton, F.R.S., has kindly undertaken to deliver the Juvenile Lectures this year on "Electricity and its Applications." The lectures will be delivered on Wednesdays, January 3rd and 10th, at 3 p.m. They will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, December 13th, 1916; The RIGHT HON. THE EARL OF SELBORNE, K.G., P.C., G.C.M.G., D.C.L., late High Commissioner for South Africa and Governor of the Transvaal and the Orange River Colony, in the chair.

The following candidates were balloted for and duly elected Fellows of the Society:—

Collett, Leopold George, Merle House, Evesham.

Deas, Edmund Percy, 52, Larkspur-terrace, Newcastle-upon-Tyne.

Notley, Miss Mabel Emily, Larksfield, Englefield Green, Surrey.

Pegler, Alfred, 81, Palace-road, Streatham Hill, London, S.W.

Souza, Francis Xavier Da Silva e, 17, Nakayamate dori, Nichome, Kobe, Japan.

The paper read was—

THE DEVELOPMENT OF IMPERIAL RESOURCES.

By H. Wilson Fox.

Some of you may have read the articles which I recently contributed to the *Times* upon the subject with which this paper deals. Those articles pointed out that at the end of the war we must necessarily look forward to an Empire debt, and an annual national expenditure of such dimensions that, unless some new method of dealing with national finance can be devised, we shall be faced with a burden of taxation which may become a very serious menace to our national well-being and progress. I urged that before we resigned ourselves to such a prospect we should consider whether there was any practicable alternative, and suggested that the solution of our financial difficulties lay in the systematic development by the State for the State of some of the at present undeveloped resources of our vast Empire.

I propose this afternoon to enter somewhat more fully than was possible within the limits of those articles into some of the varied aspects of this suggestion, and with the special object of viewing it primarily from an economic standpoint.

I shall refer briefly in the first instance to some of the criticisms which very naturally have been made upon it. The first which I shall mention is rather political than economic. People say, "Oh, this is rank Socialism; we cannot possibly agree to proposals of this nature; we do not know where they will lead us. This is the thin end of the wedge!" Or, as a friend of mine has wittily expressed it, "They will say, 'You want to make me a Socialist. I have only just begun to think Imperially, and now you want me to think Socialistically.'"

The answer to this criticism appears to me to be that we are Socialists all the time. It is a mere question of degree, and if, by being slightly more Socialistic than we are at present, we can all be a great deal better off I for one am quite prepared to be a Socialist. But I think that the real reason why so many people are frightened at the bogey of Socialism is that, like so many other words which have been flung into the melting-pot of political strife, it has become besmirched, and meanings have been attached to it which are quite foreign to its proper connotation. Moderate people have been led to regard a Socialist as a man who wants to rob someone else—that is, a man who ought to be watched all the time and handed over to a policeman on the first opportunity. Let me assure you, right here as an American would say, that that is not the sort of Socialism for which I have any sympathy. On the contrary, I want the State to leave money in people's pockets, instead of taking it out of them, and to create new wealth for itself—in the general interests of all of us—by developing, or helping to develop, a fraction of the vast undeveloped resources of the greatest Empire which the world has ever seen, and I believe ever will see. We are certainly Socialistic in our expenditure; let us try to be Socialistic in the right sense of the word in creating our revenue.

But again it is said, "Ah, but in doing what you propose are you not depriving individuals of their legitimate opportunities? Are you not running the risk of undermining the very bases of our national greatness, and of destroying that individual initiative and application to which we have mainly owed our past prosperity?" I think that there is a great deal more in this criticism than there is in the first one, and I freely admit that if the effect of my proposals must necessarily be to interfere gravely with the work and opportunities of individuals I should certainly be opposed to them myself. But I believe that activity begets activity, and that well-ordered State action will, so far from diminishing the opportunities of individuals, very greatly enlarge them. Who will dare to place a limit upon the opportunities offered by our Empire? We have hardly as yet touched the fringe of the possibilities. Increased production, whether by the State or by individuals, will, if wisely planned, necessarily increase both population and consumption by giving to each and all better facilities for satisfying their desires; while education, research and organisation are daily giving rise to a better return for effort. In other words, as time goes on, we ought to be able to live better while working less. There is not the slightest necessity, so far as I can see, why State action such as I propose should interfere detrimentally either with capitalist or with labourer, except in cases where any fair-minded man would think it right and just in the general

interests of the community that it should do so. As to this it may be said, "Yes, that seems right on the face of it, but it is too general. We should like to know more definitely what limitations it is proposed to place on State action?" The answer to this question is important, and can, perhaps, be stated best as a series of propositions:—

1. The State should not compete with private enterprise except where such private enterprise tends to become a private monopoly and to "hold up" the consumer.

2. Its intervention must always be on a sound economic basis.

3. Public industrial enterprise should as far as possible benefit capital as well as labour.

4. It should be clearly shown to be in the national interest.

5. It should be shaped and directed to the exploitation of natural monopolies, natural wealth, industries vital to public safety, key industries, seasonal trades, and industries affecting public health.

This statement of the proper limits of State action is not my own, and it covers somewhat wider ground than that with which I am concerned this evening. I rejoice to tell you that it is taken from an article recently contributed by Mr. Victor Fisher, one of the ablest members of the Labour Party, to the *British Citizen and Empire Worker*, and I find in it a message of great hope and encouragement. If that is the spirit in which these great problems are being approached by prominent members of what will sooner or later become the most powerful section of this community, we need have no fear for the future of our Empire. To solve our problems we must approach them in a non-partisan temper, in a spirit of broad-minded tolerance and unhampered by preconceived prejudices; and, above all, we must escape from the poisonous atmosphere spread by old political shibboleths which even this great war has not as yet finally destroyed. We must look at things as they are and pay no heed to what they may be called, and we must welcome clear thinking and patriotic ideas wherever we may find them.

The next criticism which I shall mention is of the nature, "Physician heal thyself." I have heard it said, "How is it, if State development is practicable, that the British South Africa Company cannot show better results after all these years?" This is not an occasion when I can enlarge upon the work of that great Company; but, in reply to this criticism, I will point out certain facts in regard to Rhodesia which furnish, I think, a sufficient answer. It must not be forgotten that when Rhodesia was first occupied in 1890 it was a barbarous and wholly inland territory, separated from the nearest centres of civilisation of South Africa by many hundreds of miles of sandy desert, and from the sea at Beira by over two hundred miles of broken mountainous country, of tropical forest and poisonous swamps. Until railways had been carried to its border in 1898 development in any commercial sense was impracticable, and the more so because many hundreds of miles of line had still to be built to link up what are now the main producing centres with each other and the sea. The South African war broke out, you will remember, in 1899, and it was followed by a period of great financial difficulty. I have no hesitation, therefore, in asserting that the real development of Rhodesia only began less than fifteen years ago, and in claiming that a country which, in the circumstances of Rhodesia, has already developed an external trade of about £8,000,000 per annum, has every reason to be proud of its present condition and to be sanguine as to its future. A Board of Imperial Development is not likely to select for its initial work portions of the Empire which present similar difficulties. It will have a wide choice of opportunities, and will naturally deal with them in the order of their respective attractiveness. Any comparison with the work of the British South Africa Company is consequently liable to be completely misleading.

I have reserved to the last the criticism which is the most difficult of all to answer satisfactorily. It is concerned with the question of State management. People say: "The State never could and never can manage any commercial enterprise successfully. Civil servants are notoriously even as children in business matters, and, besides, any organisation such as you propose is bound to fail, because it must inevitably become a hotbed of political jobbery." The only answer to be made to this criticism is that it ought not to be so. There are plenty of men available in this country who have given their proofs in the management of great business undertakings. Our fellow-countrymen are not inferior in their powers of organisation to the organisers of any country in the world, not excepting Germany; and, having the material, it seems to me that it would be a most humiliating confession of national incapacity to assume that proper use cannot be made of it. Moreover, in this special

direction the war has been a great educator. The State is to-day by far the greatest of our industrial employers in respect of the operations of the Munitions Department alone, and many of its factories are equal if not superior in lay-out and equipment to any others in the world. In many directions action which might have been impracticable, or at any rate very difficult, before the war has become to-day comparatively easy; and I, for one, believe that a great extension of State activities in the sphere of the production, distribution and exchange of wealth could now be successfully organised with great benefit to the Empire. At any rate I am certain that efforts in this direction ought to be made, and I am confirmed in this view by consideration of our national financial position.

I do not propose to weary you this afternoon with a mass of figures, partly because all such figures, and especially estimates for the future, can be only, to say the least, approximate. I think, however, that it may be useful to restate some of the considerations which lead to the conclusion that some new system for raising a large proportion of our State revenue is urgently needed. It appears to be more or less agreed by statisticians that our national income before the war was about £2,400,000,000, and that the accumulated wealth of the United Kingdom was about £16,000,000,000, and of the Empire about £30,000,000,000. Partly owing to the recent rise in prices these figures have now changed considerably; but, as I am concerned rather with the wealth itself than with the valuation of it, the pre-war figures will best serve my present purpose. The pre-war savings of the nation per annum are estimated at something less than one-fifth of the national income, and, it must be remembered that out of this fund of from £400,000,000 to £500,000,000 per annum the nation has relied for the improvement of its machinery of production. It is not, therefore, to this surplus income that the State can primarily look for the supply of the greater part of its new heavy requirements. To cease to maintain and improve our machinery of production would spell national danger of the gravest character. It must also be remembered that our requirements on account of plant will be very considerable in the first years of peace, and are never likely to return to pre-war figures; because, if production is, as we all hope, to be increased we must spend more money on the purchase, maintenance and improvement of power and labour-saving plant. The demands for this purpose upon our national surplus income will consequently be increased.

Given an adequate supply of capital, and a fresh start in the relations between capital and labour, it is possible, and even probable, that the income from our home industries may increase sufficiently rapidly to make up, say within ten years, for the diminution of our income caused by the sale of our foreign investments, and possibly to furnish the further sums needed for the replacement and improvement of our national plant. But I greatly doubt if it will also supply within the same period a further large margin out of which the new demands of the tax-gatherer can be completely met. To provide the balance the alternatives, therefore, are either to induce greater national economy, or to find some other source of State income, or both. The distribution of national income makes it very doubtful whether under existing social and political conditions it is possible or desirable to impose greatly increased taxation upon that portion of the national income which is received by persons having an income of less than £700 per annum. That portion probably represented not less than £1,850,000,000 out of a national income of £2,400,000,000, and by far the greater share of it was received by persons in receipt of incomes of less than £150 per annum. On the other hand, if the greater portion of the burden were cast upon the recipients of the remaining £550,000,000 the consequences, as I have indicated, would probably be highly injurious to future production.

It is necessary to consider these matters seriously, because the future additional requirements of the State are likely to represent a high proportion of our former margin of saving. In my recent articles I estimated tentatively the post-war national expenditure including Sinking Fund at £460,000,000 per annum, being an increase of £261,757,000 per annum on the pre-war figures. To-day, I consider that an increase of at least £300,000,000 will probably be nearer the mark, bringing our national expenditure to upwards of £500,000,000 per annum. If the greater part of this additional £300,000,000 cannot, as I suggest, be taken from people with large incomes without national danger, and if we are forced to rely upon taxation alone to meet State necessities, then the burden must fall upon the poorer classes of the community. Such a result would certainly give rise to widespread suffering, and the more so because satisfactory methods of taxation have still to be devised.

With regard to our accumulated wealth, Sir George Paish* has pointed out, "That it is for the most part merely the land on which we live, manufacture, trade and grow our crops, our factories, railways, machinery, shops, houses, furniture, etc., and that its value consists in its use for purposes of production and of income. . . . Thus our accumulated wealth for the greater part consists of the machinery of production, using the term in its broadest sense, of use for the purpose of production, but unavailable for any other purpose than production."

I quote this statement because it suggests the reason why we should now look with hope and expectation to our overseas estates to help us to make good the heavy losses of material wealth which the war has caused us, and to assist us to meet our national liabilities. The reason broadly is this: We have in many of our Possessions the machinery of production already partially assembled; but, the machinery being still incomplete, it cannot as yet be described as accumulated wealth. It is potential wealth, and more remains to be done before it can be converted to our immediate use. We have the fertile lands there, and the labour, and with a modicum of capital—and above all, by the aid of effective organisation—the whole machinery of production can be assembled and set to work. Out of an income of, say, £2,400,000,000 per annum, with a margin of saving for purposes other than the necessary extension of our machinery of production of considerably less under pre-war conditions than £500,000,000 per annum, it would not be easy to provide for the extinction of debts of from £4,000,000,000 to £5,000,000,000 with an interest charge of from £200,000,000 to £300,000,000 per annum. On the other hand, to increase the accumulated wealth of the Empire, by, say, 20 per cent. in a reasonable period, from, say, £30,000,000,000 to £36,000,000,000, need not necessarily be a difficult task, bearing in mind that, in the United Kingdom alone, our accumulated wealth is estimated by statisticians to have increased by about £3,000,000,000 in the ten years immediately preceding the war. It should, however, be noted that, as Sir George Paish has pointed out, accumulated wealth does not necessarily mean consumable wealth, to which alone we can look for the service or satisfaction of our national debts. Consumable wealth, which for national purposes may be roughly defined as wealth which can be converted into cash, may, however, exist in many different forms, and in particular may include land for which purchasers can be found.

There is no doubt that many of the undeveloped resources of the Empire can be developed profitably. The first point to be decided in principle is whether the State should in regard to some of them take an active part in their development; or whether in all cases it prefers to leave their development to individuals, assuming itself the position of an agricultural or mineral landlord. In the latter case its overseas revenues will continue to be derived almost entirely from taxation, the sale of unimproved land, or mineral royalties. We are, however, confronted with an unprecedented financial position, and we must decide whether we are satisfied with our existing methods. At any rate it cannot be wrong to appoint a competent expert board to consider these questions. The means which can be employed most advantageously to develop particular forms of wealth may be different. In one case it might be clearly good policy for the State to act directly on its own account; in another through the instrumentality of a corporation in which it takes an active interest and participation; in a third it may be best to leave the whole business to individuals.

There are many ways in which, if it decides to do so, the State can take a direct share in production and the operations consequent upon it. It may, for instance, as an owner of land, develop and cultivate the land itself, and not merely sell or lease it to others who will engage as individuals in the business of mineral or agricultural production. It is to this form of State activity that my present proposals mainly relate, though I am equally in favour of direct State activity in connection with industrial or trading business, provided it can be shown that action in these directions can be taken on lines which will, so far as can be foreseen, be sufficiently remunerative, and which will not be likely to have a discouraging effect upon industrial enterprise generally.

I may point out that the various forms of activity to which I have referred cannot be kept entirely distinct. It is again all a question of degree. A farmer when he brings a crop of corn to maturity is a producer from land, when he thrashes it he becomes an industrialist, and when he markets his grain, in a limited sense, a trader—a trader in the ordinary sense of the word being a man who derives his profits

* *Journal of the Royal Statistical Society*, May, 1916.

from dealing with the produce of others. But, as I have said, the proposals for which I am responsible are mainly concerned with the profits which can be made for the Empire by the development of lands which, being owned or controlled by the Crown, can be dealt with without any interference whatsoever with private rights. Such realisable wealth as may be derived from, or created by, their development will be new wealth, and will be in the form of assets which, if held by the State, can be regarded as a set-off against liabilities; or, if sold the proceeds can be used either to pay interest on liabilities, to extinguish liabilities, or for general Imperial purposes.

It is interesting to note that financial problems similar to those which we are considering here are also receiving attention in Germany, where the necessity for raising greatly increased State revenues after the war is at length becoming realised. A well-known German writer has recently laid it down that "the general principle is: the more an industry lends itself to the formation of syndicates, the more suitable it is for State participation." The same writer —referring mainly to industrial syndicates— points out that the easiest way in which the State can raise large funds, is to give special positions, by way of monopoly or otherwise, to large syndicates, receiving in return a participation in their profits. He points out that by this means "the State money will be abstracted during the process of production before it has become private money." He says: "Milliards must be raised somehow, and consequently the national economic system must be hindered somehow and at some place. Wealth must unquestionably be withdrawn, the only problem is by what method. The method here indicated has the immense advantage over all other conceivable ones in that it makes for commercial and technical concentration and improvement. The self-interest of producer-associations is made to serve the interests of the State."

It is very evident from this passage that the German writer, Professor Naumann, whom I have quoted at such length, grasps the difficulty of raising the vast sums which his State will need by ordinary methods of taxation. He realises, and he is quite right, that no one likes taxation, and he, therefore, very properly casts about for some alternative plan. Even before the war the undeveloped resources of Germany overseas were incomparable with those possessed by the British Empire, and as this great source of new wealth is denied to him he very naturally looks to other forms of production, in which the State can participate directly with financial advantage to itself and without injury to the capitalists and individuals who are already engaged in them. As I have already said, I see no objection to proposals of this character which might be seriously considered in this country also with great advantage, and especially in connection with the provision of public facilities, such as electric power and means of transportation, where, owing to the uncoordinated manner in which they have hitherto been provided, an immense waste of wealth and effort is taking place. If a fresh start were made under the highest professional advice, and with the aid of State credit or funds, I am credibly informed that it would be possible for the State to derive a revenue of hundreds of millions sterling per annum, while at the same time improving the position both of producers and consumers. It is obvious that savings in cost of production have the same effect on national wealth as direct additions to national income.

Professor Naumann's dictum that the State should, so far as possible, assume the ownership of wealth before it has passed into private ownership, obviously presents no difficulty in its application, when the wealth in question is derived from land of which the State is already the owner. In this case what the State has to consider is not whether it will take wealth from the private individual, but to what extent, and on what terms, it will permit private individuals or corporations to take part in the development of State lands. From my personal experience of work of this character, I can unhesitatingly say that while the circumstances of different territories are infinitely varied, there must necessarily be sufficient similarity between the problems which they present to make it advisable to appoint a Board for the Conservation and Development of Empire Resources, and to entrust to it the task of deciding in each case how State lands and minerals can be conserved and developed with the highest benefit to the State.

It is no new thing to constitute such a Board. In this country we are familiar with the work of the Commissioners of Woods and Forests and of the Development Commissioners, who are engaged in a comparatively small way with the management of State property and with limited schemes for development. Their work might be extended in this country with great advantage, but overseas there are far greater

opportunities which hitherto have not been dealt with on sound lines, and as part of an ordered State policy. The handling of valuable assets in our Crown Colonies and Protectorates has been left to Colonial Governors and Civil servants, who are not qualified by their training and experience to settle the many complicated business questions which this work entails, with the natural consequence that the best use is seldom made of natural resources, nor is the State reaping those direct advantages which could be secured to it if a different policy were adopted.

It would be premature at this stage to define too closely the limits and character of the work to be carried out by the proposed Board. So far as my proposals are concerned it will be limited to conserving for State purposes, land, minerals, and other natural sources of wealth which the Crown owns or controls. I do not extend the word "conserve" to cover such operations as the recent purchase of the wool-clip of Australia in order to ensure that the products of the Empire shall be available in the first place for its citizens. That may very often become a highly necessary policy, but I cannot discuss it this afternoon. The Board I have in mind will have plenty of work to do without assuming, in addition, the control of the trading operations of individuals for purposes outside its primary objects, which will be directed to increasing the revenues of the Empire.

The first step to be taken will obviously be to obtain accurate information in regard to the undeveloped resources of the Empire and their possibilities. I believe that the Committee of the Imperial Institute and other bodies are now engaged in investigating these matters. Their work in this direction will be most helpful, but without some such further organisation as is now proposed much of the value of this work will be lost.

As regards the terms upon which the great Dominions might be willing to permit a portion of their natural resources to be developed by an Empire Board it would be premature and ungracious to discuss them. Where there is a will—and, above all, good will—there is always a way. Both the Imperial and Dominion Governments will have much to gain by mutually satisfactory arrangements, and to our brethren overseas the attraction presented by the prospect of early development of resources which otherwise may lie fallow for many years to come, may probably be relied on to neutralise to a very great extent calculations as to the profits which might be derived if they elected to await the time when they could develop their resources on their own account. Development gives rise to increased population, and increased population spells increased revenues and political strength. Add to these considerations a heartfelt patriotic desire to assist the Home Country and the Empire in its difficulties, and there can be no doubt as to the result.

Pending arrangements with the Governments of the Dominions, the work of an Empire Development Board must be confined to the Imperial Crown Colonies and Protectorates, to India, and to such new Colonial territories as may fall to our share on the conclusion of the war. Even in this more limited field the opportunities for successful action would be very considerable. You will not, of course, expect me to make definite proposals for action, because expert inquiry must necessarily precede such proposals. I will, however, mention to you later various promising suggestions which have been made, which may serve to illustrate the nature of the work with which it is thought that the proposed Board might concern itself with advantage.

In my recent articles I did not specially refer to the undeveloped mineral resources of the Empire which raise questions of great complexity. It is no use to be the owner of minerals of the existence of which you are not aware; it follows consequently that in dealing with its mineral wealth the State, like any other owner of minerals who does not wish to prospect for them himself, must offer sufficient inducements to private prospectors, otherwise nothing will happen. I have no time this afternoon to discuss this very complicated question at any length, and will content myself with suggesting at this stage that one of the first duties of a Board for the Conservation and Development of Empire Resources should be to consider the whole question of State-owned minerals, and decide by what means they can best be dealt with, so as to secure the maximum of benefit to the State. In the case of large deposits of iron and coal, and of other minerals of which the extent and value can be more or less ascertained at comparatively small cost, it might pay the State well to work the deposits itself. But the extent and value of the majority of mineral discoveries cannot, as a rule, be ascertained without heavy initial expenditure, and their working is usually, from a business point of view, a speculative operation. In such circumstances the owner is often well advised

in either permitting them to be worked in return for a share of the profits earned, or on payment of a rent or royalty. It is possible, however, that it might pay the State to retain the right to resume possession of any mine discovered on public land at stated intervals, on payment to the licensee of adequate compensation for disturbance, and in respect of the values disclosed by his past work.

As regards land, the means by which the State can utilise State-owned land for the purpose of meeting State liabilities are either (1) to sell or lease it in its natural state or as improved land; or (2) to use it itself as an instrument of production—*e.g.*, for the raising of stock or for the establishment of plantations. I stated in my articles my conviction that it would probably not pay the State to engage directly in ordinary agricultural operations. Land, therefore, which is primarily suitable for such operations should, I think, as a rule be sold to private individuals or corporations after such expenditure, upon or in connection with it, as may appear in each case to be justified.

Action such as I have suggested, if carried out on a large scale, will usually demand the provision by the State of a number of facilities, such as water-supplies, railways, harbours, grain elevators, and factories for the manipulation of agricultural produce, all of which should be designed to show a reasonable profit on the cost of establishing them. Some would doubtless be highly profitable. In others the margin of profit might be slender; but the general rule should be that, unless the cash value of the indirect advantages could be shown to outweigh considerably the loss to which the provision of an unpayable facility would give rise, the work should not be undertaken. As an instance of such facilities I refer to the Assuan Dam, a highly profitable undertaking, and to the Uganda Railway, which, after many years, is beginning to provide a modest return on the capital embarked in it.

I have indicated previously that the native population of our tropical possessions may properly be included in any review of our undeveloped national assets. The war has shown us the effect upon production which may be exerted by the introduction of new classes of workers into the industrial system. But whereas in this country we must look mainly to improvements in organisation and machinery to bring about increased production, we are still able in our overseas Possessions to attract large numbers of new recruits to our industrial armies, many of whom are already known to be capable of acquiring a high degree of technical skill.

How important this labour reserve, which is very largely untapped, may become is evident from the following table, which shows the areas, native populations, and external trade of a number of British Possessions in Africa, and also gives similar figures for Egypt and German East Africa.

Territory.	Area in square miles.	Population.		External Trade.	
		European.	Native.	Imports.	Exports.
Nigeria	335,700	2,600	16,258,000	6,331,751	6,779,205
East Africa Protectorate .	200,000	3,500	4,000,000	2,147,937	1,482,876
Uganda	121,437	1,017	2,904,454	897,262	524,260
Nyasaland	39,315	799	1,063,912	189,201	200,734
Gold Coast Colony . .	80,000	1,700	1,503,386	4,952,494	5,427,106
Sierra Leone	31,000	1,191	1,401,941	1,750,303	1,731,252
Gambia	4,000	149	146,101	1,091,129	867,187
	811,452	10,956	27,277,794	17,360,077	17,012,620
Egypt	363,461	221,139	12,000,000	26,583,000	35,474,000
German East Africa . .	348,318	5,336	10,000,000	2,667,925	1,777,552

The success of any proposals for the development of tropical regions will, in most cases, depend upon the extent to which native labour is available, and upon its cost and efficiency. These matters are specially important in connection with the future of our tropical Possessions in Africa. Nor can we shirk consideration of what should be our policy and methods in connection with the supply of native labour to local industries and native policy generally. The adoption of sane, just, and practical views in regard to native ownership of land and native labour is above all essential.

The problem of civilisation in new territories is to convert the indigenous native into a useful human being, to improve his value to himself and to the world at large, and to effect this change with as little hardship as possible to the individual. Similar problems have to be dealt with every day in wholly white communities, and the best solutions are found when substantial justice is done between man and man. Personally I hold most strongly that our duty, both to ourselves and to our native fellow-subjects of the Crown, lies in widening their horizons, and in offering to them all available opportunities for raising themselves in the scale of civilisation. By all means, from the point of view both of humanity and of self-interest, regulate closely the conditions and circumstances of labour, and let the State be jealous to protect the native against the cruel, careless, or dishonest employer. That, however, is a very different matter from endeavouring to prevent the natives of Africa from taking advantage of the opportunities which the spread of civilisation in their own or neighbouring British territories is offering to them.

From the point of view of self-interest also we cannot afford to neglect these matters. At great sacrifice of life and treasure we have given to millions of natives in Africa security of life and property. We can fairly claim that the natives shall in return bear their share of the Imperial burden. The native equally with the European has his duties and responsibilities to the Empire. The elimination of the slacker is as important overseas as it is here, as is also the application of the doctrine of the dilution of labour. In the best interests of the Empire and of themselves, European Colonists in tropical regions must be brought to realise that the solution of nearly all economic problems lies in maintaining the highest efficiency and the maximum of production, and that in order to attain these conditions native labourers should be trained and utilised to the fullest extent which their individual aptitudes allow. The possibilities of these regions are immense, and if their development be handled on these lines no European workman need be under any apprehension that there will be no work for him. There is always work for all in a period of rapidly expanding production.

It may be of interest to consider what the development of native territories in Africa has already added to the trade of the Empire. It may fairly be claimed, though it has been disputed, that the gold mines of the Witwatersrand could not have been brought to their present condition of prosperity by the aid of Europeans alone. These mines now produce gold to the value of nearly £39,000,000 per annum. Rhodesia has, as I have told you, a trade of about £8,000,000 per annum, of which about £6,000,000 is with the United Kingdom. This trade has practically arisen in about fifteen years, and is the result of the settlement of about 32,000 Europeans in a region sparsely inhabited by about 1,750,000 natives.

Then there are the territories of which details are given in the table to which I previously referred: Nigeria, the East Africa Protectorate, Uganda, the Gold Coast Colony, Nyasaland, Sierra Leone, and Gambia. The aggregate area of these territories is 811,452 square miles, they are inhabited by 10,956 Europeans and 27,277,794 natives, and their external trade is £34,372,697, of which far the larger proportion is carried on with the United Kingdom. Now compare their position with Egypt, where there is a total area of 363,461 square miles, a cultivated area of not more than 1,200 square miles, a native population of about 12,000,000, and an external trade of about £62,000,000. It is true that this population has been trained in habits of industry for generations. Is it not, however, obvious that the opportunities for a rapid expansion of wealth in the other territories which I have mentioned are extraordinarily encouraging, bearing in mind their numerous and various mineral and agricultural resources?

The development of each of these territories has as yet hardly begun, and it is quite impossible to forecast what their future value to the Empire's trade may become, when their resources have been further investigated and their available man-power has been better trained and organised. It must be remembered that every producer is also a consumer, and that if means be found to increase the purchasing power of the native inhabitants of our African

and other tropical territories a very valuable and expanding market will be secured for our manufacturers and merchants. From this point of view alone the State would be justified in incurring some risk in order to accelerate the development of these promising regions.

What then are we to expect of German East Africa when this great and partly developed territory has become, as I trust it may in its entirety, part of the Dominions of the Crown? In this wealthy tropical region there are, I believe, upwards of 10,000,000 native inhabitants, and its European population before the war was about 5,000. Its soil and climate are known to be suitable for the production of varied and valuable tropical products. A number of commercial estates have already been established, and data have been collected from which important conclusions can be drawn. It should offer a very promising field for State investment, and the possibilities in this direction will not, I trust, be overlooked.

It is important to note that the tropical Possessions of the Crown in Africa and elsewhere will probably never become the home of any considerable number of Europeans, who will continue to be primarily overseers of native labourers. In these circumstances there is no reason to suppose that these territories will ever receive any large measure of local self-government, and there will be the less difficulty in regarding them mainly from the standpoint of estates of the Crown which should be developed for the general benefit of the Empire, and at the same time of their native inhabitants. In such circumstances the extent to which individual European planters should be encouraged to make these territories their home will be an important question of policy to be decided in each case by the nature of the activities upon which the State itself may elect to embark. The establishment of any large central industry usually results in the creation of subsidiary industries; it is therefore quite possible that a policy such as is suggested may have the result of increasing rather than limiting the numbers of the European population, while possibly restricting the operations of large investors and corporations.

It may be added that one of the methods by which the State can derive profit from its tropical estates is to keep in its own hands the power of producing, trading in, and exporting certain special products, and especially products in which either a complete or partial monopoly can be established, such as jute and palm products. In the present embryonic condition of our tropical Possessions, all vested interests could be adequately compensated where necessary at comparatively small cost, and in the majority of cases it would be quite possible to safeguard the interests of European producers and traders without the payment of any compensation at all. These, however, are also matters which would naturally be studied closely by the proposed Board, by whom the issue of licences to trade and export would in such cases be controlled.

I have told you previously that it is not possible at this stage to lay before you any definite proposals, and before I give you some illustration of the work which the State might conceivably undertake, I should like to express my conviction that the study of markets must be an essential preliminary to action. It is not the slightest use to produce commodities for which there is not a regular, assured and increasing demand at prices which, so far as can be foreseen, will be satisfactory, or for which there are not good grounds for believing that satisfactory markets can be built up. Of the staple commodities of trade, foodstuffs must be placed first in regard to magnitude and certainty of demand; next in order come probably products required for the manufacture of clothing; next metals, minerals and mineral oils; and in the fourth place of those which I propose to mention I should place the fibres such as jute, flax, coir, and sisal hemp, which are required for so many purposes in our daily lives. I have omitted, you will see, paper-making materials. Their position in the list would naturally turn upon whether you regard our newspapers as luxuries or necessities.

It appears to me that, given favourable conditions, the State could engage with great safety and confidence in the production of many commodities which are included in the above categories. Take, for example, vegetable oils and fats, in which, if we choose to do so, we can establish to some extent a monopoly position. I ventured to suggest in my recent articles that our facilities for the production of palm products in Africa and the Pacific are so great that we might derive an income of £50,000,000 a year from these commodities alone. As the result of information which I have since received, I am convinced that my estimate was probably a modest one. In considering this question of vegetable oils and fats, I must not omit to mention the ground, pea, or monkey nut, which is destined to play an important part in

the future in the supply of those oils and fats for which even to-day all Europe is crying out, and for which it will cry still more as the populations increase and the supply of animal fats continues—as it must—to diminish. In these commodities there is a world demand, and restricted possibilities of supply. It must, therefore, be good business for us, who have the power in great measure of controlling the supplies, to engage in the business of their production on a large scale.

My next illustration, which I mention at this stage with less confidence because I am not yet satisfied that a sufficiently wide market can be developed, is concerned with one of the important fibre-producing plants, commonly known as sisal. I refer to it partly because we possess in the Empire very large areas of land which are suitable for its production, and partly because the trade figures of German East Africa show how rapidly this industry can be established. The latest report available is dated July, 1914, and states that the production for 1911 was 11,212 tons, that the crop for 1912 was about 16,500 tons, and that this figure is more than four times as great as the corresponding figure for 1908. From inquiries which I made in East Africa in the early part of 1914 I have reason to believe that the average net profit per ton can safely be estimated at from £10 to £12, so that the profit on 16,500 tons would exceed £165,000, and would thus pay interest at 5 per cent. on upwards of £3,000,000. In suitable localities this plant can be grown practically without risk, as it is exceptionally hardy and has no known pests.

Finally, I will mention a proposal which emanates from my friend, Mr. Bigland, and which has already been referred to in the press, though very inadequately, in a report of a speech which he made recently. Mr. Bigland has been impressed by the vast extent of our Empire littoral and its convenient proximity at many points to the most valuable ocean fisheries of the world. He realises, as Mr. Moreton Frewen told you here last year, that the fishing industry is probably the most productive of the large industries of the world in relation to the capital embarked in it, and to the value of the product per caput of the men engaged in it, and he suggests that the extension of the demand for fish is purely a matter of improved organisation of the machinery for distribution, and particularly in connection with the provision and use of efficient refrigerating plant. He, accordingly, believes that there is here a wide and promising field for State enterprise, and proposes that the State should take an active part in the distribution and wholesale marketing of fresh fish. Fishermen would be assisted to supply themselves with improved plant, and arrangements could be made without difficulty to protect all existing vested interests. With proper organisation and appliances it should be possible to supply the produce of the great Pacific and Atlantic Canadian fisheries to Europe, and possibly also to develop the great fishing grounds of the Antarctic. We should at the same time encourage the establishment along the coasts of the Empire of a vastly-increased number of those brave and hardy fisherfolk to whose unadvertised efforts we are largely indebted for that high degree of protection against submarines and mines which we have enjoyed during the war. Moreover, I believe that our Admiralty is at the present time in possession of the finest fishing fleet ever built. From the point of view of war insurance alone this project deserves most careful consideration. As to profits, I am not at liberty to give you Mr. Bigland's rough estimate. I will, however, permit myself to say that I greatly doubt if he would be satisfied with any less figure than the £50,000,000 at which I have had the temerity to estimate the possible amount of profits from palm products.

Nothing is to be gained at this stage by multiplying illustrations. Other suggestions of a promising character have already been made and are in course of being studied. The proposer of one of them—a large land development and settlement scheme which certainly merits most careful investigation—suggests that from this source alone the whole of the National Debt could be paid off within, say, forty years. If a very much smaller amount could be discharged by this means, I am sure you will agree that we should have every reason to be contented.

While it will be desirable, as a rule, that the proposed Development Board should concern itself mainly with large-scale enterprise, and leave to others the smaller avenues of production, it does not follow that this rule should be observed strictly in cases where several branches of production can be prosecuted together advantageously. On the principle that "many a mickle makes a muckle," the cumulative results of the cultivation of minor products might in time be quite considerable.

But you may say, "Granted that these

proposals are in the main practicable, where is the money to come from after the war to give effect to them ?" The answer to this question was given in part in my articles, in which I suggested that a portion of the Sinking Fund, which would otherwise be devoted to paying off debt, should be invested in State enterprises of the nature which I have indicated. But I also now suggest another source from which large sums might be derived, viz., the savings of the poorer classes of the community, who have hitherto had very little opportunity of making safe and attractive investments. I cannot pursue this matter deeply now, but my suggestion in broad outline is, that moneys from this source should be accepted under a State guarantee in regard to the capital, while as to interest, a minimum rate might be guaranteed by the State, and a higher rate paid, if earned, up to a fixed maximum. These investments would thus partake of the nature of participating and fully-secured debentures, the State itself being the stock-holder. I hope that after the war a Board of National Saving may be constituted to deal with these and similar matters.

Finally, you may say, "Granted that the schemes are sound and practicable, and that the money for their execution can be found, how long will it take to give effect to them ? How soon can the State expect to receive substantial benefits ?" You will readily understand that the answer to this question will probably be different in each case. Looking at it, however, from, so to speak, an average point of view, I should personally not expect large-scale results in much under ten years, though in regard to particular enterprises, some of my friends take a more sanguine view. Think, however, what a reasonable expectation of such results as I have foreshadowed would have upon the public mind, what a load of anxiety it would remove, and how greatly it would affect the policy of the country in regard to taxation. If, after close investigation by experts, it were decided that these proposed State activities could be undertaken with every prospect of success, it might even be legitimate, as I have suggested, to continue to borrow during the post-war reconstruction period, in order to relieve the pressure of taxation at a time when the nation will be least able to bear it.

That concludes the remarks which I propose to make this afternoon upon this very fascinating subject. I hope I have at least succeeded in convincing you that proposals such as I have indicated merit serious consideration, and that you will, each and all of you, do your best to see that they are not swept on one side, or rejected, without adequate inquiry.

DISCUSSION.

Mr. Alfred Bigland, M.P., who opened the discussion, said the difficulties in the way of developing our overseas resources were very great, and it was only men of sanguine temperament who could think in times of war like this of the things that had to be done in the future. He himself was one of those men of sanguine temperament who did not believe in difficulties, who did not believe in impossibilities, and who believed that the British Empire was such a marvellous asset to our race that the wonders that could be achieved were greater than had ever been imagined. The question of Socialism must be looked at in a new sense. He had always been an individualist, and had dreaded the idea of Socialism as ordinarily understood. Under the new State Socialism, however, we were not going to steal something from somebody else but were going to create wealth. Speaking of the productivity of the soil, there was no better instance than Cuba. When the Americans took over Cuba they offered £2 per ton more for sugar grown there than for any other. Immediately capital, enterprise, and labour were turned into the Island of Cuba, with the result that an annual output of 600,000 tons of sugar was in seventeen years turned into 3,000,000 tons. In Western Canada there were at least 200 million undeveloped acres which the enterprise of the British race could bring into actual work over a term of forty or fifty years. Mr. Moreton Frewen went so far as to say that even the United States would not be able to produce enough for their own population in twenty years' time, and that the British Empire could produce enough to satisfy our own needs and export to the States as well. Mention had been made of fisheries, and if there was one thing that we could legitimately take up from the point of view of Socialism it was fisheries, because nobody paid rent for the ocean. Moreover, we possessed a great deal of land alongside the ocean where fishermen could make their bases. In the Antarctic, for instance, we owned every bit of land where a fishing company could establish itself, and at the present time it was impossible to fish in the Antarctic for whales without a licence from the British Government. Along the Pacific coast of British Columbia we were in the same position. There we had a very long coast, and it was all swarming with fish. The difficulty was to get that fish to market. Some people had been going into the matter, and he believed the Grand Trunk Pacific was prepared to run special trains fitted up with refrigerating plant from Prince Rupert through to Montreal or Quebec, and from there to connect with Liverpool or London by rapid steamers. It was estimated that on the cost of

carriage alone, the fish could be delivered at 1*d*. per lb., the cost of getting the fish, of course, being extra. He agreed with Mr. Wilson Fox that it would take ten years to develop some of those enterprises, and he hoped they would not be mixed up with the Chancellor of the Exchequer and his taxation. They did not want the Chancellor of the Exchequer to say that he would tax the profits for revenue purposes. What was wanted was a Board on the lines laid down in the paper for the whole of the Empire, so that every part of the Empire could be asked to put into the hands of the Board some portion of its assets that it was not using now. When that was done we should, for instance, always be able to smoke British Empire tobacco. Jute, too, had already been mentioned. The Indian Government did not obtain much money for jute, but he would manufacture jute within the British Empire, and if anybody outside wanted it he would have to pay a very high price to get it. There was no jute grown in the world except within the British Empire. These were just a few suggestions he wished to throw out in the hope that they would be followed up.

Mr. Moreton Frewen said the world was suffering to-day from the fact that the school of economics or the school of philosophy, which was to some extent discredited to-day, was the school that they were all brought up in. He was thinking of his own days at Cambridge, when it was considered an absolute heresy to suggest that the State should do anything. He remembered crossing the Atlantic with the late Professor Herbert Spencer. The Professor talked about the infamies of State agency, and was so extraordinarily acid about the idea of the State doing anything for its citizens that he replied at last, "Professor Herbert Spencer, if I held your views I should regard it as absolutely immoral to post a letter in a State letter-box." Later he (the speaker) wrote a small book — thirty to thirty-five years ago—called "The Socialism of To-morrow," and that little book was perhaps worth recalling for this reason. He said that the line of cleavage was roughly this: that the production of wealth should be left to the individual, and the distribution of wealth, as far as possible, should be left to the State. In particular, he thought the State should undertake railroads, banking, and insurance; but it was regarded as rather a radical view at the time. However, as everyone knew, a few years later Bismarck adopted the whole of the State Socialism proposed by certain German philosophers, with such extremely satisfactory results that the problem of mere wealth had been absolutely solved in Germany. When we felt downcast at the colossal debt that the Empire was piling up at the present moment we should look for an instant at the assets of the Empire. If we could mobilise the wealth of the British Empire for the purpose of paying off the National Debt on something like the lines advocated in the paper, the debts we were incurring need not weigh in the smallest degree with any of us. He should like to say a word on the question of State ownership of railroads, which was undoubtedly one of the questions that were coming up for solution. Some twenty-five years ago the Hungarian Government reduced the third-class fare from one penny per mile to one penny for three miles. Some railway experts thought the extraordinary State experiment would be a failure. During the first year there was a small loss, but the year after that the Hungarian State railways earned more profits than they ever did before. It also enabled the population of the mountainous districts to get down to the rich Danubian province to gather in the harvests, and then to return to vivify the whole life of the villages. Something of the same kind happened when the first railway was built from Ottawa. The Canadian Pacific people were told that nothing but disaster could follow the building of a railway into the inaccessible regions. But what happened? The earnings of the Canadian Pacific were then ten million dollars a year; to-day they were 140 millions. Mr. Bigland had mentioned fisheries. Last year he himself read a paper before the Society on the State and the fisherman, and pointed out that in other countries, where the fisheries were less important and infinitely less valuable than ours, the State was spending large sums of money, with the result that the men who worked for six months in this industry were, in the United States and Canada, earning twice as much as the men who worked twelve months on the land. Canada was spending ten times as much on her fisheries as we were spending here, and the United States twenty times as much. The removal of the shad fisheries from the Atlantic to the Pacific by the United States had resulted in the creation of enormous wealth, the waters for 3,000 miles of the Pacific were alive with this valuable food fish. In this country we had got into a ruck of individualism, or were so weighed down by Herbert Spencer and a crowd of philosophers, that we had done nothing with our assets. Really, he almost felt that Germans were justified in starting this infamous war when they saw how, enjoying all the best of the globe, we had done so little to develop it. The whole conduct of statesmen in this country for fifty years had been nothing short of criminal.

Mr. J. W. Stead asked if Mr. Fox was in favour of the nationalisation of mines, the nationalisation of the railways and canals, the displacement of the Post Office system, and the nationalisation of life insurance, as supplementing the new acquisition of wealth from the sources he had mentioned. Further, had private production proved a success during the war, and was the increased wealth to be distributed in a more equitable manner than at present? Finally, were we now fighting for territory, because Mr. Fox had said we were going to keep German East Africa. Were we fighting for territory or justice?

The Hon. Sir John McCall said the chief and most important part of the paper related to the use of the undeveloped resources of the Empire for the purpose of paying off the debt incurred during the war. The other matters that had occupied the attention of the various speakers could be left over for the present. He thoroughly endorsed everything that had been said on this aspect of the question, and there would not be, in his opinion, the slightest difficulty in finding the men to manage the various concerns that must of necessity come into existence. In the Colonies and the Dominions they had managed their own railways for quite a long time, and no difficulty had been experienced in securing able men to work as Commissioners of Railways. Similarly, the men who had so successfully managed private industries could do equally well for the State. Furthermore, private individuals investing in industries usually looked for a return of from 8 to 10 per cent., whereas the State would no doubt be able to raise the necessary capital at 4 to 4½ per cent. The Chancellor of the Exchequer ought to find the money for the new Board which it was suggested should be formed.

Mr. T. L. Gilmour, who was a member of the National War Savings Committee, said Mr. Wilson Fox had asked him to say something on the work of that body with particular reference to the suggested National Savings Board after the war mentioned in the paper. There was evidence that many of the public had very little idea of the work the War Savings Committee was really doing. That Committee was asked by the Government to do two things: in the first place to undertake a campaign throughout the country for reducing expenditure upon things that were not necessary—and many probably only knew the Committee in that capacity—and, secondly, to establish throughout the country War Savings Associations for the collective purpose of Government securities and mainly for the wonderful Government security known as the "£1 for 15*s*. 6*d*." certificate. The Committee had now been engaged upon this work for several months, and had called in the aid of the local authorities throughout the country. The organisation so established was distinctly temporary, so far as its immediate object was concerned, viz. to raise money to assist in the prosecution of the war, but he thought it could be adapted on the lines suggested by Mr. Fox. Up to the present date there had been established in England and Wales—the Committee did not cover Scotland and Ireland—838 committees, one to each borough of over 20,000 inhabitants. Other committees had been formed in smaller boroughs, and there were also a number of county committees. The main object was to appeal to the small investor, and there had been established 15,758 War Savings Associations which had sold 50,988,381 "£1 for 15*s*. 6*d*." certificates. At the same time through the Post Office, and in other ways, £9,453,380 worth of 6 per cent. Exchequer bonds had been taken up—all contributions from the small investor. The total contribution of the small investor since August 1914 amounted to £111,176,000 in 4½ per cent. loan, 5 per cent. bonds, and war certificates for small amounts. This showed that there were large untapped resources available for the provision of capital for the purposes indicated in the paper. In France and other Continental countries the small investor was very well known, but in this country we could not claim in the past to have been a very thrifty people. At any rate we had not formed the habit of investing, and in this connection he ventured to think that the War Savings Committee was doing work which would extend far beyond the war. Habits were now being acquired by the working-classes of this country which he was quite certain would remain with them in the future.

The Hon. J. G. Jenkins asked Mr. Fox if he had considered the question of funding the whole of the Imperial war debt at the conclusion of the war? The Dominions were incurring a large war debt on their own account at a rather high rate of interest, and we also were incurring a large debt at a high rate, and the funding of all these debts was a subject worthy of notice.

Mr. Wilson Fox, replying to the last question, said it was premature at this moment to come forward with any considered ideas with regard to pooling war debts. There must be a conference to deal with all these matters arising between the Imperial Government and the Dominions, and we must not approach this question with ideas too much crystallised. Consequently all he had said in this connection had been purposely nebulous. From the financial point of view there was a great deal to be said for pooling; but he would be sorry to say anything that might have a prejudicial effect upon future arrangements. Replying to Mr. Stead's questions, he said he was dealing primarily with economical and not political questions, and also with the question of dealing with our undeveloped resources. He had suggested, however, that he was not personally against State action in other directions, if the State saw its way to make money out of it, and if, in doing so, the Government did not interfere too much with general industry and individuals. He had also suggested that these matters would have to be considered by a Board of experts, and he did not profess to be either a Board or an expert. Therefore he did not think he could answer these somewhat difficult questions, many of which were highly controversial. One of the questions, however, was easy to answer, viz. the one in which he was asked how the results of State action would be distributed. He did not think the State would distribute it at all, because if it succeeded in making money it would put it in its pocket, and use it for State purposes. As individuals the public would not get a dividend,

although that might come in time, but he did not have that in mind at present. The best that the public could hope for to begin with was fewer calls by the State in the way of taxation. As to whether we were fighting for territory, he did not think it necessary to decide that in principle, but if at the end of the war we found ourselves in possession of the whole of German East Africa, and we did not get sufficient indemnities to pay us for everything that the war had cost us, he had no objection to our remaining in possession of German East Africa. He regarded the matter from the commercial point of view. He did not see why we should be out of pocket if we could force Germany to put us in a better position.

The Chairman (The Right Hon. the Earl of Selborne, K.G., P.C., G.C.M.G., D.C.L., LL.D.), in proposing a vote of thanks to Mr. Wilson Fox, said he was one of the brilliant group to which Mr. Moreton Frewen and Mr. Bigland belonged, who, at a time when our statesmen could not possibly think out these questions and were wholly occupied in the business of the war, had come forward with a series of probably the most pregnant suggestions that had been put before the British public on the subject of Empire economics within the last century. It was very refreshing to hear Mr. Moreton Frewen's onslaught on the utilitarian philosophers and the politicians who for so many years had been bemused by their doctrines. All the points put forward in the paper deserved very careful consideration; they suggested the difficulties which had to be met, and the questions which must be studied, and none of the criticisms could be regarded as an effectual barrier to a consideration of the great questions that had been indicated. We must be prepared to face the future—political, social, and economic—divested of all the prejudices which had gathered round us, no matter to what party we belonged. The whole of the circumstances of the country, the Empire, and the world were going to be different from what they had been before, and there would be no chance of successfully coping with these circumstances if we allowed ourselves to be trammelled by the shackles of opinions and prejudices which we had inherited from thinkers of the past, who never had to deal with circumstances in any sense parallel or analogous to those with which we now had to deal, and of which they, in their wildest moments, never contemplated the possibility. All the problems set out in the paper were at present only in the stage of suggestion, and the amount of thinking that had to be done to bring them to useful fruition was very great. Nobody was more conscious of that than Mr. Fox and his associates, and he personally regarded that meeting as a distinct step—not the first, or even the second, but perhaps the third step—in the study of this problem.

The vote of thanks was unanimously passed.

ENGINEERING NOTES.

A Russian Canal.—The rivers of Russia, though they are the longest in Europe, have a most sluggish course and flow into the inland seas for the most part. They rise in the great Russian central plains, and for that reason present great opportunities for work in the direction of canals and canalisation. A scheme at present in hand was planned to cost £16,700,000. The idea is to make a great canal, divided into portions. The first was to consist of the regulation of the western Dwina from Riga to Vitebsk, and was to be 360 miles in length. The second portion was to be the canal proper from Vitebsk to Orsha on the Dnieper, fifty-two miles long. The third and southern portion would be the regulation of the Dnieper from Orsha to Kherson, 1,055 miles long. In all the canal would, when complete, be 1,473 miles. It will be at once perceived what an immense gain to Russia the proposed canal will be when constructed. It will traverse her richest agricultural district, and greatly facilitate the export of her grain. The chief towns upon this waterway include several important centres. These export, among other items, grain, timber, flax, naphtha, petroleum, sugar, tobacco, fruit, and vegetables. What the country wants mostly is agricultural machinery and manures. Germany has hitherto supplied Russia with these; it remains for Britain to do it in future. The economical and strategical value of this canal is concentrated in one fact—it would to a great extent make Russia independent of the Dardanelles. Goods would pass in twelve days from the Black Sea to the Baltic. Some progress has been made with the canal. In the summer of 1913 a good deal was done between Ekaterinoslav and Gradizkok in the way of blowing up submerged reefs and obstructions to small rapids, and deepening river beds. A large sum of money was allowed for this portion of the work, and it was expected to take four years. The deepening of the river between Ekaterinoslav and Kiev has been commenced. From Kiev to Orsha the banks have been strengthened and the channel deepened. In the Vilna district a fresh canal has to be made from Orsha to the Dwina. On the Dnieper from Alexandrovsk to the sea the canal is ready for use. Had the whole canal been ready for use, how greatly it would have aided Russia just now. The above has been abridged from an article on the general subject of internal water communications of Russia in *Chambers's Journal*.

Power from a Volcano in Tuscany.—This remarkable installation, giving power by the generation of natural steam, is described by Professor Luiggi, D.Sc., M.Inst.C.E., in *Engineering*, and is briefly as follows. As is well known, in Central Tuscany, near Volterra,

there are numerous cracks in the ground, from which powerful jets of very hot steam spout high in the air with great violence and constancy, bringing up boric acid, which is very valuable, and other mineral substances of less importance. These powerful jets of superheated steam are called *soffioni*—the "blowers"—and have been utilised for many years in the production of boric acid and borax, and occasionally for warming the houses in the near-by village of Larderello. The larger proportion of the steam, however, is lost, having no local application, and with it is lost its very valuable heat. Prince Ginori-Conti, the President of the "Società Boracifera de Larderello," tried to get a more ample supply than is afforded by the borax works, by boring holes in the ground, lined with iron pipes, driven down to the very source of the steam, which is under a hard stratum of rock about 300 to 500 ft. below the surface. These bore-holes vary from 12 to 20 in. in diameter, and give forth steam with a pressure from 2 to 3—and, exceptionally, up to 5—atmospheres, and at temperatures varying from 150° C. to 190° C. For several years these jets have not diminished in their capacity, nor does a new boring seem to interfere with the preceding ones, provided the distance from one to another is not less than 50 ft. Acting on the advice of the Tosi Works, of Legnano, specialists in steam turbines and alternating electric generators, he ordered three groups of condensing turbo-electric engines, each of 3,000 kw., working with superheated steam at 1½ atmospheres, generated in specially constructed multitubular boilers, the latter arranged vertically and with aluminium tubes, both for better utilisation of the heat and better resistance to the corrosive action of the natural steam from the *soffioni*. This steam, it is worth while to repeat, is used instead of combustible; it loses part of its heat in the boiler, reducing its temperature from 180° C. to about 120° C., and is then utilised for the borax industries. The steam thus generated in the boilers and used for the turbines is ordinary water steam, which on its way to the turbine passes along aluminium pipes heated outside by a current of superheated natural steam, at 180° C., and thus gets in its turn superheated to about 150° C. After passing through the turbine this steam is discharged into a surface condenser, the circulating water of which is in its turn cooled in an ordinary cooling tower. The condensed steam from the turbines is, of course, pumped back into the boilers, and thus no natural steam ever comes in contact with the turbine. The tri-phase electric current is generated at 4,500 volts and 50 periods per second, raised up through an oil transformer to 36,000 volts, and sent along aerial conductors to Florence, Leghorn, Volterra, Grosseto, and many smaller towns of Tuscany, to be principally used as motive power for munition works during daytime and partly for lighting purposes at night. One of the 3,000 kw. units has been at work since January 1916, the second since April, and the third has just been started. So far, the first two groups have worked quite successfully, and have been a great boon to the industries of Tuscany, greatly crippled by the scarcity and high price of coal. This very successful harnessing of volcanic heat to an electric power-house can be increased practically to hundreds of thousands of horse-power, as the region of the *soffioni* extends for many square miles around Lardello. Similar installations to the above are contemplated near Naples, where there is another large area giving out steam.

Wireless Telegraphy on Aeroplanes.—According to American reports, says the *Wireless World*, what is claimed to be a record in wireless telegraphy from aeroplanes was recently established by Captain Culver, of the United States Aviation Corps. During a flight from San Diego to Santa Monica, 114 miles away, he is stated to have kept in touch with his station by sending wireless messages every three minutes. The power for the transmission set is derived from a generator placed on the lower wing section of the aeroplane, and is driven by a two-bladed propeller. Aerial wires are suspended from the "fuselage" of the machine, with an insulated counterpoise hung from the wings to the tail of the aeroplane. The complete transmission set is stated to weigh less than 40 lb.

OBITUARY.

William Wallace Blair.—Information has been received of the sudden death from heart failure of Mr. William Wallace Blair, of Victoria, British Columbia, at the age of sixty-four.

Mr. Blair was a native of Tyrone County, Ireland. He went to Canada, and about twelve years ago established himself at Winnipeg, where he followed the profession of architect. As a member of the Royal Architectural Institute of Canada he was widely known in the Prairies. He settled in Victoria about two years ago and retired from practice.

He was elected a Fellow of the Royal Society of Arts in 1909.

NOTES ON BOOKS.

The British Empire at War. By Urban H. Broughton, M.P. London, 1916.

In this little brochure of fifty small pages Mr. Broughton describes briefly, for the benefit of his numerous friends in America, the principal steps taken by the British Empire in the conduct of the war. In surprisingly few words he gives a clear account of the present state of the army,

the navy, the air services, the tremendous work of the Ministry of Munitions (which, at the time of writing—September 1916—controlled 4,319 firms and 2,250,000 employees), finance, trade, and our mercantile marine.

Mr. Broughton certainly makes out a very good case for the part taken by us in the war, and it is no doubt desirable that neutral nations should be made aware of what we have done. We believe that he could have made the case even better had he dwelt a little longer on the auxiliary services we have been rendering to our Allies—such facts, *e.g.*, as that we have furnished the French armies with 10,000 miles of telephone and telegraph wire, and that the very stones used for repairing the streets in Northern France are sent over from England. No doubt, however, the author was embarrassed by the wealth of his material, and he has certainly managed to compress a great amount of information into a very little space.

WIRE AND SHEET GAUGE TABLES. Compiled by Thomas Stubbs. London: E. & F. N. Spon, Ltd. 3*s.* 6*d.* net.

These tables have been compiled for the use of merchants, manufacturers, and those connected with the wire, sheet steel, and other metal industries. The book contains English, metric, and foreign sheet gauge tables, with net and gross divisors for finding out and working weights, allowances for mill scrap, etc.; it also gives the weights of all sections of precious and common metals, and English and metric weight and measure tables, with their equivalents. The calculations have been made with great care, and so far as we have been able to test them, the figures are accurate. As a metal calculator and ready reckoner the tables should prove very useful for office and shop use.

GENERAL NOTE.

STANDARDISATION OF CARGO VESSELS.—A pamphlet has been issued by the United States Department of Commerce, entitled "Standardisation in the Construction of Freight Ships," and is intended to encourage the building of vessels for the foreign trade of the United States. It was written for the Department by Mr. E. P. Stratten, Consulting Engineer of the New York Board of Underwriters and formerly Supervisor of the American Bureau of Shipping. The author states that he finds in the United States signs of a disposition so to standardise the construction of cargo types of steamships as greatly to reduce their cost. He believes that the successful development of this tendency will go a long way towards making the United States entirely independent of other countries in the construction of ships for its foreign commerce. Details of construction are discussed, and it is proposed that the country's great steel plants develop a thoroughly well-standardised system of supplying dimension materials, shaped and punched, ready for assembling in the hull of any standard ship of specific dimensions. Copies of the pamphlet may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a cost of 5 cents (2½*d.*) each.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

DECEMBER 20 (at 4 p.m.).—A. C. BENSON, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education." THE RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., will preside.

JANUARY 24.—W. A. M. GOODE, Hon. Secretary, National Committee for Relief in Belgium, "Relief Work in Belgium."

JANUARY 31.—MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France."

FEBRUARY 7.—ROBERT FORTESCUE FOX, M.D., "The Future of British Spas."

FEBRUARY 14.—LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

Dates to be hereafter announced:—

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

OCTAVIUS C. BEALE, "British Arts and Crafts after the War."

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel."

SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

January 18, February 15, March 15, April 19, May 17.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

January 30, February 27, March 27, May 1.

HOWARD LECTURES.

Monday afternoons, at 5 p.m.:—

WILLIAM RIPPER, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m.:—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 6, 13, 20.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications." Two Lectures.

January 3, 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 18...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. J. Thorp, "Order in the Modern City, and London in Particular."

Bibliographical Society, 10, Hanover-square, W., 5 p.m. Mr. S. Wheeler, "Notes on the Bibliography of Landor."

British Academy, in the Theatre, Burlington-gardens, W., 5.15 p.m. (Schweich Lectures.) Professor L. W. King, "Legends of Egypt and Babylon in Relation to Hebrew Tradition." (Lecture II.)

Geographical Society, Burlington-gardens, W., 8.30 p.m. Mr. R. H. Compton, "New Caledonia and the Isle of Pines."

Faraday Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8 p.m. 1. Messrs. R. G. Parker and A. J. Dalladay, "On a Precision Method of Uniting Optical Glass—the Union of Glass in Optical Contact by Heat Treatment." 2. Dr. W. C. McCullagh Lewis, "The Effect of Pressure on the Equilibrium Constant of a Reaction in a Dilute Solution. A simple proof of the expression." 3. Mr. E. D. Campbell, "Do Equiatomic Solutions in Iron possess Equal Resistances?" 4. Mr. R. H. Sherry, "Grain Growth in Deformed and Annealed Low Carbon Steel." 5. Messrs. E. Griffiths and E. A. Griffiths will describe and exhibit a New Electric Furnace for testing the Softening Points and Compressive Strengths of Refractory Materials.

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Sir Guilford Molesworth, "Indian Weights, Measures, and Money."

TUESDAY, DECEMBER 19...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. S. L. James, "Notes on the Subject of Geological Mapping."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Mr. G. Drage, "The Reorganisation of Official Statistics and a Central Statistical Office."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Discussion on Mr. P. M. Crosthwaite's paper, "Experiments on Earth-Pressures."

Colonial Institute, Hotel Cecil, Strand, W.C., 4 p.m. Miss Edith Browne, "Possibilities for British Trade in South America after the War."

WEDNESDAY, DECEMBER 20...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Mr. A. C. Benson, "Classical and Scientific Education."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Mr. C. Salter, "The Measurement of Rainfall Duration." 2. Professor H. H. Turner, "Discontinuities in Meteorological Phenomena." (Third Note.)

Microscopical Society, 20, Hanover-square, W., 7 p.m. 1. Professor Sydney J. Hickson, D.Sc., F.R.S., "Certain Sessile Forms of Foraminifera." 2. Mr. A. Bacot, F.E.S., "Note on the relation between the Hatching and Development of the Larvæ of the Yellow Fever Mosquito, *Stegomyia fasciata*, and the presence of Bacteria and Yeasts."

THURSDAY, DECEMBER 21...British Academy, in the Theatre, Burlington-gardens, W., 5.15 p.m. (Schweich Lectures.) Professor L. W. King, "Legends of Egypt and Babylon in relation to Hebrew Tradition." (Lecture III.)

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. G. Senter and G. H. Martin, "Studies on the Walden Inversion. Part V.—The kinetics and dissociation constant of a bromo-β-phenyl-propionic acid." 2. Messrs. R. H. Pickard, W. Lewcock, and H. de Pennington, "The alcohols of the hydro-aromatic and terpene series. Part III.—The isopulegols corresponding with l-menthol and d-neomenthol." 3. Mr. H. G. Denham, (a) "Lead sub-iodide with details of the preparation of lead sub-oxide"; (b) "Note on the solubility of lead iodide." 4. Messrs. A. F. Joseph and W. N. Rae, "Chromium Phosphate."

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. C. Robbins, "Odds and Ends."

Historical Society, 22, Russell-square, W.C., 5 p.m. Rev. Claude Jenkins, "The Historical Manuscripts at Lambeth."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Professor H. Adams, "Pile Driving and the Supporting Power of Piles."

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. W. H. Goodchild, "The Economic Geology of the Insizwa Range."

FRIDAY, DECEMBER 22...Colonial Institute, Hotel Cecil, Strand, W.C., 3.30 p.m. (Juvenile Lecture.) Mrs. Blount, "British East Africa and Lake Victoria Nyanza."

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Journal of the Royal Society of Arts.

No. 3,344. VOL. LXV.

FRIDAY, DECEMBER 22, 1916.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

INDIAN SECTION.

Thursday afternoon, December 14th; The RIGHT HON. LORD EMMOTT, G.C.M.G., and subsequently SIR WILLIAM DUKE, K.C.S.I., K.C.I.E., Chairman of the Indian Section Committee, in the chair. A paper on "The World's Cotton Supply and India's Share in it" was read by MR. JOHN AITON TODD, B.L., Professor of Economics, University College, Nottingham.

The paper and discussion will be published in the next number of the *Journal*.

JUVENILE LECTURES.

A Member of the Council, Mr. Alan A. Campbell Swinton, F.R.S., has kindly undertaken to deliver the Juvenile Lectures this year on "Electricity and its Applications." The lectures will be delivered on Wednesdays, January 3rd and 10th, at 3 p.m. They will be very fully illustrated with experiments.

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 20th, 1916; The RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., in the chair.

The following candidates were proposed for election as Fellows of the Society;—

Boag, George L., Aguilas, Murcia, Spain.

Lovejoy, Frank W., 1438, Main-street, Racine, Wisconsin, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Baker, George Percival, Ivydene, Cold Blow, Bexley, Kent.

Heap, Arthur Cecil, Vickers House, Broadway Westminster, S.W.

Knight, Berkeley, Bradley, Overton Drive, Wanstead, Essex.

Wagner, Orlando Henry, M.A., 90, Queen's-gate, S.W.

THE CHAIRMAN, in introducing the reader of the paper, remarked that it was often said that education was a singularly dull subject. Whether that was due to the fact that the controversies which concerned it very often turned upon well-worn themes, and concerned themselves with administrative details which were apt to be dry, however important; or whether it was owing to the fact that education was a subject of such an immense number of commonplace remarks, which were not so far from the truth that it was possible to contradict them, but which at the same time very seldom seemed to hit those real underlying principles in which the subtle truth and essence of education were placed at their practical value, he did not propose to inquire; but he could promise the audience that it would not be dull on the present occasion. Mr. Benson's name and fame were well known, and he had had an educational experience of unusual variety. He had seen education from every conceivable point of view—as an under teacher and as a head teacher, as the Don of a college and

as the Head of a college, and as a writer upon educational subjects in many forms; while his charming essays, in which he had treated both of education and of many other subjects, were well known and read with constant and fresh enjoyment.

The paper read was—

LITERATURE AND SCIENCE IN EDUCATION.

By A. C. Benson, C.V.O.,
Master of Magdalene College, Cambridge.

There is a very amusing caricature by Mr. Max Beerbohm of the poet Coleridge in his later days, when he lived at Highgate, planned important books in many volumes—not a line of which was ever written—and talked philosophy to all who cared to come and listen. The picture represents Coleridge holding forth in a deep abstraction, with his eyes fixed upon the Absolute, and the guests all asleep—not politely and decorously slumbering, but plunged in a lethargy so profound that they are heaped up against each other, like a bundle of sausages. Such, strange to say, is the sort of effect often produced by those who venture to discourse at large upon education. The strangeness lies in the fact that education is almost the only subject in which almost every man feels himself to be an expert, and claims the right to hold and express an opinion. Yet it is admittedly a dull subject, and, perhaps for that very reason, that all feel equal in discussing it. The expert contemns the amateur, the amateur mistrusts the expert. I myself have had a fairly wide experience of education. I was a public school master for twenty years, and I have been a Don and College lecturer for twelve more. I have been a diligent member of a county education committee for a good many years, and I have sat on every single sub-committee at various times. I am on three school governing bodies, a public school, an urban day school, a county grammar school, and I have been for some time on the governing body of a teachers' training college, besides being for a period on the consultative committee of the Board of Education. These are my credentials for addressing you; and I may say that I have come to the conclusion that the practice of education is one of the most interesting things in the world, and the theory of it one of the dullest, for the reason that it reduces itself mainly to very minute and complicated questions of finance.

The fact is that in England we have tackled the matter of education from the administrative side, and, like true-born Britons, we have had a deep suspicion of the philosophy of it. What is the aim of education? That is the one question to which we have never attempted to give an answer. Is it to prepare a man for earth or for heaven? Is it to train the character, or the imagination, or the intellect? Is it to turn out good citizens, or wage-earners, or well-informed men, or practical men, or healthy men, or men of culture, or idealists? What we have certainly contrived to do, without any apparent aim, is to train a generation eminently fitted by devotion and public spirit, and self-sacrifice and bravery, and discipline and cheerfulness, to become in an amazingly short time a generation of excellent soldiers. And in reforming our education it would be worse than childish to overlook that. In spite of all strictures, we have produced the right article at the right moment, and it is a result of which we have every right to be proud.

Personally, I believe that the aim of education is primarily the training of character, and in this respect I believe that we may be said to have succeeded far beyond reasonable expectation or unreasonable hope; and whatever we do to alter our education we must contrive to keep that ethical element. Intellectually, we have not done so well. We have not succeeded in kindling intellectual interest, and I further believe that we have not made the most of our resources of definite technical ability. The framework of a system is all there, but we have not taught the right things, or we have not taught them in the right way; we have not sufficiently developed individual capacity; and I believe that the reason why we have not succeeded here is that we have not sufficiently recognised the differences of temperament and taste. We have compromised, because we have begun with the notion that it is possible to find a type of education which is applicable to all alike, and what we have called a sound general education has not been a sound one at all, and only general in the sense that it suited no one in particular. It is just as if we had invented a sound general diet by trying to cater for all digestions and appetites, man, woman and child alike, without recognising the vast differences in human nature and the nuances of human inclination.

Every practical educator knows that one can divide one's material into three rough classes. At the top come the people, not very numerous, of strongly-marked individual capacity and

ability. These can often deal fairly successfully with a variety of subjects, but there is generally one subject in which they are obviously and specially proficient. I will take the third class next, and these are the people who are clearly slow and dull, and find great difficulty in applying themselves intelligently to any subject at all. Then there is a much larger second class of fair straightforward capacity, not markedly good at any one subject, and yet not markedly feeble; and it is these who are the chief problem. The first class need careful special training; the third class are probably not adapted for an intellectual education at all. The second class are really the difficulty.

The new scheme of the Board of Education is probably the best attempt which has yet been made to deal with the situation. It amounts to this: that up to the age of sixteen or thereabouts boys should be taught the things which no one can well dispense with—English, a foreign language, elementary mathematics, elementary science, history, geography, scripture, and if possible a handicraft of some sort. By the age of sixteen it is generally possible to discern an aptitude of a definite kind. After that age, then, a boy should be enabled to give a little more time to his particular aptitude, not simply specialising, but providing a sensible balance. Then, it may be hoped, the universities will be more elastic in giving to all boys, who are capable of profiting by higher courses of study at all, a chance of pursuing a special subject. Thus, it is suggested, we might turn out men who really had a subject, and moreover had the simple accomplishments necessary for efficient work in the world.

But now we come to a more difficult part of the subject. What on the whole should general education aim at? Education used to be divided into ancient and modern, the classics forming the bulk of the ancient, and modern languages with science being included in modern education. But it is clear now that this is a wholly false division. The true division is literary and scientific; and this must be considered more in detail.

The old theory of humanistic education, as it is called, was simple enough. It was an attempt to train the mind in the best that had been thought and said in the world, instead of on a subtle but arid theology. It consisted of poetry, philosophy, and rhetoric, and was based on classical literature; but it must be remembered that there was then no science at all, very little history, no geography or ethnology to speak of, very little modern literature, and little mathematics. It was partly moral and partly intellectual, and it aimed at fortifying and refining the mind.

It was not really till the nineteenth century that the modern and scientific subjects began to claim attention, and it all came with a rush. Scientific discovery, exploration, pure and applied mathematics, modern literature, all began to accumulate results and conclusions of startling import. But the old order was so firmly rooted, that it was not until some fifty years ago that these later subjects began to creep into the curriculum of schools; ever since that date there has been a steady struggle. Subject after subject forced itself in, while the old guard, the classicists, disputed every inch of the ground. The result has been a hopeless congestion, and the elements of so many things have had to be taught that only the cleverest boys contrived to assimilate what may be described as an intellectual kedgeree. Now we have come to the point when it is obvious that everyone cannot learn everything, and what we have to do is to settle a very simple core of education, providing enough variety to detect aptitude, and, as soon as aptitude is pronounced, to enable it to be cultivated.

But the danger at the present moment is this, that the classical system, thrust into a corner by modern subjects, provided so desolate and tough an education, concerned as it was with such a mass of grammatical niceties, anomalies, syntactical peculiarities, that it had not a chance itself of enlightening or encouraging its victims, and yet, by claiming so much time, kept the other subjects all in elementary stages too. The impatience and the rebellion produced by this reactionary and stagnant system have risen to such a pitch, that we are in danger of arguing that, because the classical system has failed, therefore literature has failed. I have been reading a vehement little pamphlet lately in which the author speaks of feeling "a grave concern as to the triviality of the literature to which the education of the present day leads; so much about the failings and foibles of human nature, so little about the majestic and inexorable laws of the physical side." Such reformers as these say, "For goodness' sake, let us have an end of all this nonsense; instead of feeding the minds of boys upon old human visions and fancies and imaginations, let us feed them with realities. Let us teach boys something about the world in which they have to live." With

this attitude it is impossible not partly to sympathise. But the danger, as I say, is that we may simply substitute one tyranny for another. I was always very anxious for elasticity, and worked hard for many years to break down the rigours of the classical system; but it was all in the interest of elasticity and special aptitude. I do not want to turn out the old system neck and crop, simply to introduce another system just as tyrannous and just as neglectful of temperament and aptitude.

Human perception and intelligence is somewhat sharply divided. Some minds are abstract, others concrete. Some minds are interested in ideas, in beauty, in old traditions and memories, in human adventures and experiences, in religion, in political theories, in the slow organisation of communities, in problems of government, in schemes of social reform—in everything in fact which deals with human temperament and character. Other minds are interested in more concrete things, in the phenomena of nature, properties of matter, substances, machines, contrivances, manufactures, applied science generally, by which the laws of nature are used to serve human welfare and convenience. Both these sides of life are entirely worthy of study and attention, neither is negligible, and it is worse than childish for either type of mind to allege that the preferences of the other type are unimportant.

A literary education, as it is called, is a study of all that deals with the emotions, hopes, fears, desires of mankind, and to some minds these are the transcendently important realities of life; a scientific education deals with man's material environment; and as man is a spiritual being living under material conditions, it is of the utmost importance that both should be studied and realised.

Such a statement as that which I read just now, about "a grave concern as to the triviality of the literature to which the education of the present day leads; so much about the failings and foibles of human nature, so little about the majestic and inexorable laws of the physical side," is palpably onesided.

It appears to me, in the first place, a very unscientific position to take up; for surely "the failings and foibles of human nature" are just as much scientific facts as any other thing, just as much the outcome of the "majestic and inexorable laws" of nature as any physical fact. Considering how much of science has been constructed out of the patient study of innumerable details, apparently very trivial in themselves, it is clear that the failings and foibles of human nature are, at least, as worthy as all other details of scientific consideration.

And then, too, human nature as acted upon by the inexorable physical laws is the thing, after all, which concerns and interests us most. It is true that we have to live in a physical universe and we must recognise physical laws. But a minute study of those physical laws must always be a matter for specialists. The ordinary human being has not time or intelligence to go far in the direction of scientific research, while the whole of his life is spent in contact with human nature, and its faults and foibles. It is far more important for the ordinary human being to know something about human nature than to know about ocean currents and tides, about light and heat, about stars and meteors. The only part of scientific knowledge which is of practical concern to most human beings is the elementary facts of physiology. And the practical effect of learning about the heroic possibilities of human nature, being moved by stories of courage and patience, of pity and affection, is far deeper and greater than the effect of learning about the motions of planets or the origin of storms, because none of us can escape from the problems of human nature, affecting our daily conduct and our relations with other men, learned and unlearned alike; while the properties of matter, the laws, let us say, of electricity or chemistry, are at best remote from daily life, and can only be apprehended and applied by experts. All of us, for instance, know what it is to be affected by the look of anger or affection in a fellow-creature's face; while the fact that we can only see it because a combination of carbon with oxygen produces an undulatory vibration in the ether which is luminous is not a consideration which can ever have a very wide appeal. For even when we know *how* it happens, we are not much nearer to knowing *why* it happens.

And then, too, the greater part of civilisation and progress depends not upon the scientific discoveries which add to the comforts of life, but upon the cultivation of generous motives, of disinterested sympathies, of desire for justice and order and co-operation. Human happiness is far more knit up with the art of living peaceably and affectionately with other human beings than with the inexorable laws of matter. Birds and beasts live in the universe without any scientific knowledge of its laws, but with much instinctive and precautionary acquain-

tance with them. A bird knows what food it needs, and what is dangerous, without having an idea of why it needs food, or why a course of action is dangerous; and the importance of literature is that it develops the imagination and sympathy of man, while science may perhaps cultivate imagination, but can hardly be held to develop sympathy.

I am wholly in accord with the desire to teach human beings something about the wonders of the physical world in which they live; but to turn our back upon human nature, its hopes and fears, its visions and dreams, its sins and failures, seems to me to be the most short-sighted policy. We are not yet all abstract intelligences; we are imperfect beings living in communities. Character rather than intelligence is the real aim of education, and if that is so, then "the proper study of mankind is man."

The real difficulty of the whole position lies in our vagueness of aim: we do not really know, and we have never troubled to decide, what we desire the educational process to do for our children. My own belief is that it is a threefold aim. In the first place, education should be elastic enough to enable us to discover aptitude and capacity, and therefore we want variety. The mistake of the classicist is that his ideal education is only a device for discovering literary ability, and the mistake of the modern reforming scientist is precisely the same; a scientific education is a device for discovering scientific capacity. What we need is a method of finding our future experts, for it is of the utmost importance to the race that we should discover, evoke, and use every sort of intellectual ability. What we need is an education both literary and scientific, dealing with ideas and emotions and imaginations as well as with perception and observation and exactness of mind, so that at the time when vocation begins to declare itself we may skim the intellectual cream, so to speak, and set free the best abilities and capacities to pursue their own bent. That is the first aim of education, the discovery of aptitude.

The next aim of education is a wider and more general one: it is to reveal as far as possible to the growing mind a real idea of the conditions under which it lives and will have to live. Science is an integral part of such an education, and general knowledge of physical laws and processes is of primary importance. The stars we see above us, the physiography of the globe, the laws of electricity, of weather, of heat and cold, the distribution of plants and animals, the laws and processes of life, a knowledge of mechanics, of manufacture of commodities—about these things no one should be wholly ignorant, but for many a general conception must suffice.

Then on the other side come the history of the human race, the rise of man, the growth of ideas, emotions, religious beliefs, the shaping of communities, the interplay of nations, the history, in fact, of civilisation—all this belongs to what may loosely be called the literary side. But to deal merely with scientific conceptions and laws, and not to teach how the spirit of man has developed, how he has organised human society, how he has slowly discovered and availed himself of scientific knowledge, is to leave out what is, perhaps, our main concern. What we have to do is not to leave our youthful citizens in a sort of bewildered solitude, just aware of the little circle in which they live, but to give them on one side a sense of what the natural world in which they live is like, as well as a notion of how humanity has developed its institutions and its principles.

The third aim of education is to train children in good moral and physical habits, to develop wholesome mental interests and robust health of body—the training of character in fact. But here the problem is a complicated one. If we only nurture the young in strength and health, and encourage them to believe that the world is a place to get all they can, to fortify themselves in wealth and comfort, we have not developed good citizens at all. They must learn what duty and service and self-sacrifice mean, and that a man's concern is not only himself. This can only be done by the cultivation of an imaginative sympathy, which can put itself in the place of another, and desire to share rather than to amass happiness. This can only be communicated by a perception of the beauty, the generosity, the heroism of human nature, its hopes and aims; and this I believe frankly cannot be attained by the knowledge of scientific laws, but only by human records and the noble flights of human imagination. A literary education is a feeble enough thing if it only deals with grammar and syntax, artifices of style, the jingle of rhythms and prosodies, the devices of ornament and cadence—and this was the fault of the classical education, that it so seldom broke through the outworks into the citadel itself. But the truer and more scientific view of literature is that it is the evoking of a real love of spiritual beauty, and that the masterpieces of literature are great, not because they conform to the rules of critics, but because they answer most nearly to the best and loftiest

visions of the human soul—that Homer and Shakespeare and Dante, let us say, are great because they best mirror man's greatness, and not because they afford most scope to the inquisitive pedantry of scholars. What, indeed, we have to fight against is pedantry, which is simply the fault of natures so onesided in their preference that they invest the smallest details of their study with a significance and an importance that violates all proportion. The literary pedant and the scientific pedant are alike mischievous, because they worship detail and disregard design.

The aims, then, of education are the fortification of health and character, the communication of a general conception of the world as it is, both socially and physically, and the discovery of aptitude and ability, so that the resources of the State may not be wasted or dissipated.

Our education, then, must be framed on these generous and elastic lines. What wasted time and energy, and dispelled all intellectual curiosity in the old classical curriculum, was the futile insistence on petty detail. Few boys ever struggled through the mass of trivial elements with which they were confronted. Exactly the same will be the fate of the strictly scientific education if we exchange one tyranny for another. When I was an Eton boy, forty years ago, science was just beginning to be taught in the school. I remember well a course on hydrostatics which will serve to illustrate my point. There was no apparatus available. Our teacher gave us a general view of the subject in two or three preliminary lectures, with a few very ill-drawn diagrams on a blackboard. Still, I remember that this was not without some interest. But our teacher was really a mathematical master, and as soon as possible we began to calculate the weight of columns of water—and thus continued for the remainder of the term, so that it became a baser sort of mathematics, and induced in my mind the conviction that hydraulics was the dreariest of subjects. I remember a scene which took place at one of these lectures. Our teacher had drawn upon the board a hydrostatic press with an object in it of which he diffidently said, "It might be a cheese; it might be a hat-box." A lively youth, who has since won some distinction in literature, said in a cheerful tone: "But what is the use, sir, of all this?" To which the bewildered instructor, poising his chalk in his fingers, said: "Use? Use? What's the use of you?"

On the other hand, when I was a boy of nine, my father, who was then headmaster of Wellington College, and had a great belief in the admixture of science with literature, arranged for some popular scientific lectures for the school, and took me in to one on elementary physiology, dealing with the digestive apparatus and the blood. It was illustrated with simple apparatus and lantern slides. I can only say that it awakened my curiosity to an extraordinary degree, and I have never forgotten what I then learned.

What I would deduce from these personal adventures is this—that to most boys, even a boy like myself, whose tastes even then were mainly literary, the general notions of science are extremely attractive and interesting, but that when they come to be exactly applied they suffer the same eclipse that the classics suffer by over-emphasis on grammar.

Now I am not to be supposed to be recommending that education should be a loose, vague stimulating process. I believe that toughness and exactness of mind must be relentlessly pursued. But the question is how and when. If it is the only thing aimed at from the beginning, the effect upon immature minds is simply to obliterate interest by means of drudgery. The poisonous part of the classics, taught as if everyone was to be a classical specialist, was to hang the veil of grammar and syntax between us and literature. The mind of boyhood must be for ever wooed to learning. The boy is capable of taking an immense amount of trouble if only he can be persuaded that he is not doing work; but to extinguish his fancy, his imagination, and his curiosity is a fatal mistake. What I therefore plead for is that up to the age of fifteen, or thereabouts, the boy's interest, curiosity, liveliness, emotion, sense of beauty, sense of amusement, should be firmly kept in view. It must not be all discipline. The use of mathematics, the training in a modern language, the writing of clear and correct English, the orderly arrangement of thought, are all disciplinary; but unless there is interest and animation, all this is purely mechanical. Many a boy has a pride in authorship; the difficulty is that he has no stores to draw upon. Here science and literature can be easily intermingled, if boys can be taught to write clear accounts of experiments which they have seen. The old literary exercises were dreary because they had nothing to do with the boy's own experience. The same must be done with literature. A part of English teaching ought to be simply to show the boys how to read the great books. We used, in my Eton days, to be set a play of Shakespeare for a holiday task.

What did we do? We read the historical introduction, and we got up the notes—about such things as "kerns and gallowglasses"—we did not read the play at all, except that we learned some twenty lines by heart because we were generally asked to quote any passage we had admired. In dealing with older literature there are three sides to consider—imagination, expression, erudition. The result of our teaching was to neglect the first, to dally with the second, and to converge upon the third.

If by the age of about fifteen or sixteen you have assured a boy's interest in general ideas or science and literature, given him some sense of history, by which I mean European history of a biographical and social rather than of a diplomatic or military kind, taught him to read and write simple French, to read and write English, to calculate quickly and correctly, you have done a great deal. It is very difficult to say exactly what we mean by a well-educated boy of eighteen; but if a boy of that age can read an interesting book on some subject of general current interest with something of a critical spirit, and is not wholly at the mercy of a specious and attractive presentment; and if, moreover, in reading a newspaper he does not confine himself wholly to the athletic column, but wishes to know more or less what is going on in the world—well, I for one should be ready to admit that he was a well-educated boy.

There is a delightful story told of Hookham Frere, who was the lifelong friend of the great Canning. "I was walking with Canning," Frere said, "over Wimbledon Common, and we came to a little pool into which Canning gazed with a lively curiosity. 'Frere,' said he, 'what are all those funny little black creatures crowded together and swimming about so busily?' 'Tadpoles, of course,' said I. 'These are tadpoles, are they?' said Canning. 'I have heard the name, but never saw them before. And, pray, what *are* tadpoles?' 'Well,' said I, 'they *are* tadpoles, but they *will* soon be frogs.' 'But these are not frogs,' said Canning, 'nor in the least like them; they are a sort of little fishes.' 'Don't you really know,' I said, 'that tadpoles are the young of frogs?' 'No,' said Canning, 'I never heard of such a thing; are you sure? They are the oddest little things I ever saw.'"

"Now," said Hookham Frere to his auditor, "don't you go and tell that story to the first fool you meet: Canning did not know that tadpoles turned into frogs, but he could rule a great nation, and he would not have ruled it any better or any worse if he had known. There are hundreds of things just as true and real which none of us know. It wasn't his business to know about tadpoles; it was his business to know about politics and foreign affairs, and to be a good judge of men."

This story goes side by side in my mind with a story of the poet Clough. A sort of consternation had been caused among a party of Dons by a very active politician who had admitted that he had never heard, so far as he knew, of the battle of Marathon. Someone said to Clough afterwards, "Is not that simply incredible?" "I don't know," said Clough. "I don't see what difference it made to him not knowing about it. Of course, it has made a great difference to us all that the battle of Marathon happened, and that the West held back the East. But no doubt many more important things happened in pre-historic times about which we do not know. I don't see what difference the mere knowledge makes."

There is much truth in that. We are much too disposed to think that knowledge in itself is valuable. It is valuable precisely in so far as it inspires and animates and trains the mind. The mere knowledge of facts is very unimportant. The expert must know the facts and processes of his subject, of course; but apart from expert knowledge, no knowledge is valuable which does not mean the kindling of interest and faculty. The fact which one cannot forget is the significant fact, not the fact which it seems easy to confuse or impossible to remember. In my own mind, certain facts are self-evident almost, while others melt like snow in a thaw; but I do not, therefore, hold that the facts which I remember are important, and that the facts which I forget are unimportant—it is all a question of the range and quality of minds, and the extent to which facts modify the work they are doing. I cannot help feeling that in the present push for science as an educational subject a certain confusion exists between the practical utility of science and its value as an educational subject. Elementary and general acquaintance with concrete phenomena and technical processes has no practical utility at all; it is the expert who is useful, the highly-trained specialist. A thing which is practically useful has not necessarily any educational value. What we want to discover is a subject or a set of subjects which quicken intelligence and observation and sympathy and accuracy, which extend the imaginative horizon, which make a man accept his duty and his place in the State,

not as a matter of unpleasant necessity, but as a matter of active and eager concern. I do not believe myself that any one subject can do this. If literature, as it has been taught, has failed to exert this influence, I see no reason to believe that science *per se* will do it either. While we abominate the aggressive and mediæval theories of domination which have plunged Europe into strife, it is the tendency of, at all events, a section of our community to point to Germany as a country which has contrived to produce an extraordinary average of efficiency, a formidable unanimity of aim. Yet, if we look at German secondary education, we find that science is actually taught for fewer hours in their schools than in our own. That has been established by the new Committee which is examining the question of scientific education. It is certain, I believe, that if scientific education has not had a fair chance, it is not for want of time or of apparatus—it is much more a question of method, and still more of teachers. This is really where our difficulty lies. We do not believe sufficiently in education to pay our teachers properly or to make it a career for the best men. The personality of the teacher is the root of the whole matter. What we want is men not only of clear intellect, but men with a touch of inspiration, with a living interest in the beauty and nobility of the subjects they teach. There are many dormant seeds of interest and faculty in boys' minds which can only be quickened to life by something ardent and fructifying in the mind of the teacher. A good teacher is hardly cumbered by a bad curriculum, a bad teacher is hardly assisted by the best curriculum. It may be said that it ought not to be a question of money, but you cannot expect any but the real enthusiasts to embrace a profession which hampers them at every turn with straitened resources and pecuniary anxieties. A man who wishes to marry and bring up his children liberally and intelligently will go where he can find the means of doing this. You may depend upon it that we shall do nothing in education by a mere juggling with curricula; we shall only do it by securing good and enthusiastic teachers. The imitative faculty of boys is great; and if they see a teacher who really derives animation and joy from his subject, they will wish to acquire the same happiness. Education is not a scientific process; it is a contact of living minds. I remember once examining a number of educational experts on the question of the curriculum. Each of them had some one subject which he declared had solved the question of discipline and drudgery by evoking a natural interest in the pupils. It gradually dawned upon me that each was selecting the particular subject in which he was personally interested; and I perceived that what had carried the day in each case was not educational technique but personal enthusiasm.

Let me, then, very briefly summarise my conclusions. What we want is a simple and elastic curriculum which shall cater for individual taste and aptitude, and correspond in a general way with human faculties and interests. Intellectual discipline—by which I mean that most valuable power of mastering a subject whether you are interested in it or not—can be attained to a certain extent by the uncongenial subjects whatever they may be. But I do not believe in intellectual progress being possible without intellectual interest. The general aim of this curriculum should be to give the pupils some conception of the world as it is; and in this science, literature, art, music, history, geography, mathematics, handicraft, language and religion must each have a part. Imagination, logic, clearness, observation, interest—these are qualities at which we should aim. Then, when special aptitude is discerned, in the later stages, a certain specialisation may begin. What really happened in classical education was that, under the guise of a pretended width of culture, all minds alike were forced into a premature classical specialisation, and this mistake we must not repeat. And, lastly, we must make the profession of teaching remunerative and dignified—that is the most important point of all; and unless we can do this we may shift our curriculum for all eternity without ever emerging out of a ramshackle sort of drudgery which will continue to hang like a dreary veil between the ingenuous child and the glowing interests of the great world in which he has to live and play his part.

DISCUSSION.

THE CHAIRMAN (the Right Hon. Viscount Bryce, O.M., D.C.L., LL.D., F.R.S.), in opening the discussion, said he had seldom listened to a discourse of forty minutes which contained more truth put more brightly and agreeably, and the only difficulty he had in commenting upon it was that it raised so many interesting lines of thought. He would, therefore, confine his attention to some of the most important propositions that had been laid down, and the conclusions most suitable to the present time. In the first place, the author had said with perfect truth, although the obvious

fact was often forgotten, that there was in most minds a hopeless confusion between the practical utility of a subject and its educational knowledge. The two had literally nothing to do with each other. The things which were of most use might be the things which an individual could not learn or understand. For instance, nothing touched an individual, next to his conscience, more than his health; but if he undertook studies in physiology and pathology, with a view to making himself capable of dealing with his own health, he did the very worst possible thing for it—he would always be in the doctor's hands. In the second place, the author had stated that literary subjects, and, above all, studies of the ancient classics, had been ruined in the minds of most boys by the undue insistence upon those grammatical minutiæ which might be interesting to the teacher, and which were, in a certain sense, the foundation of a thorough knowledge of the languages, but many of which were beyond the intelligence of the ordinary boy, and of little or no value for the appreciation of good literature. Long treatises had been written upon the particular use of μὴ οὐ and οὐ μή, but it was perfectly possible to appreciate Greek literature with the scantiest knowledge of both of them. That was a thing which it was earnestly to be hoped might be reformed, and it would be reformed if the new race of teachers existed for whom the author sighed. In the third place, the author said with great truth that it was necessary to pay the teachers better. The teacher was the school; the curriculum was the teacher. The good teacher made every curriculm interesting, and it was impossible to expect to have the choice intellects required for the work of teaching—especially the higher kind of teaching—without paying them better, particularly in view of the manner in which all prices had risen during the last twenty years. The country ought to be prepared to go further in that respect, feeling sure that in no direction could it make an expenditure that would be more truly remunerative. In the fourth place, the key to the question in regard to classics was that classics were an instrument for the training and developing of the mind and thought of the best pupils. Classics would be thrown away in their highest literary quality upon the majority of pupils. The problem was how so to order the arrangements of the schools and universities that it would be made certain that the classics would continue to be taught to, and studied by, the best students—whether that percentage be 20, 30 or more—who were fitted to appreciate the true value of classical literature, to make it a part of their minds, and to make it interpretative to them of human nature and of history. That was the real object of classics—to appreciate the ancient world, to get a grasp of the worth which was in those ancient races, and which was precious because of that, and without which no history could be comprehended. But how was that to be done, and how were the classics to be kept in the universities and in the higher branches of schools, with due regard to those who would not reach that point in classical study? That was the kernel of the present difficulty. They did not want to impose classical study on everyone, and yet they wanted to have the opportunity of discovering who it was that possessed the qualities which would enable him to prosecute it with real advantage to himself and real benefit to the whole community. One of the greatest difficulties which the teacher experienced at present was the passion of boys for the athletic column, to which the author had referred. He believed that no small proportion of the difficulties which teachers felt was owing to the extravagant fashion which boys had contracted, not for athletic sports—the sports themselves were admirable, and it was impossible to have too much sport and physical training for the boys—but the passion for reading and thinking about them. That was a feature which was comparatively new. When he was a boy at school there were no athletics—he wished there had been—but he was almost glad that there were none, because there was then no athletic column and no such thing as a sporting journal. There was no boy in his school of 700 boys that ever read anything about any athletic sport whatever. That was a state of things which it would be impossible to regain; *i.e.* he did not believe it would be possible to have athletic sports in a school, which were eminently desirable, without having that passion, but he thought the passion for reading about them had reached extravagant proportions. The great aim of education was to create the habit of observation, of intellectual curiosity, of thinking, and of reflecting upon what one saw. That was the real end of education in all its branches, whether it be science, literature or history. What teachers wanted to do was to make knowledge delightful to the mind. It was not knowledge that was important, but the love of knowledge. An education which instilled a real love of knowledge and the desire to make every step in knowledge a step to something else, and the basis for thought and reflection in the mind of the pupil, had attained its object. And the best education was that which did it best.

Dr. G. Armitage Smith (Principal of Birkbeck College, London) said he fully endorsed all the opinions that had been expressed upon the general problem of education. There were two sides of education—arts and science—and he had often thought that those who specialised more particularly on one of them were not as much in real contact with the subject as was desirable. The crux of the whole matter, as the author had clearly pointed out, was that training either in science or in arts up to some point was necessary to get an educated man, a man who had learned to think. If the paper were widely circulated he thought it would solve a great many difficulties that were in men's minds. During

the last year or two he had read many educational papers with the object of endeavouring to ascertain what were the correct views upon education, and he was completely perplexed; some said that science was the only thing, while others said it was arts. The author had shown that it was neither science nor arts alone, but the theory which was involved in both that was necessary—the training of the mind, the love for knowledge, and the power of expressing it.

SIR WILLIAM A. TILDEN, D.Sc., F.R.S., said that as a teacher of science for fifty years he had always held in due respect the subjects which were claimed to possess such magical powers by the representatives of literature, and he therefore felt much gratified to find that the author had shown a kind of liberality of view without which it would be impossible to get to the end of the dreadful controversy which existed. The conflict between literature and science had been going on from as far back as he could remember, and he had always thought that it was a most deplorable state of affairs. He thought it would be found, however, that it was only the extreme partisans on either side who held the extreme views. Unfortunately, some literary people, especially those who pursued the study of the classical languages, were particularly obdurate in their attitude; on the other hand, it must be admitted that some of his scientific friends went further than he personally would like to do in pressing the claims of science as a department of learning or as an educational subject on the teaching community. He thought the paper would have a very valuable effect in helping to modify the extreme views which were held by the partisans on both sides. He had felt for many years past that the statement made by the Chairman was perfectly true, that the study of the classical languages with a view to claiming an acquaintance with classical literature applied only to the best of the boys. Personally, he would like to go a step further and divide the boys into four classes. In the first place, there were the superior, intelligent boys, who were drawn on the one side to literary subjects; in the second place, there were the superior, highly-intelligent boys who were drawn to the other side, the observation of nature and the study of experimental science; in the third place, there was the mass of good boys, generally speaking, who received good reports from the schoolmaster and who made excellent citizens, but who were not brilliant: they would go whichever way their parents or their schoolmaster invited them to go. But there was a fourth class which had never been properly provided for, and he could not help thinking that much educational energy had been wasted in the past in endeavouring to make the lame ducks run. There was a certain class of boys and girls in whose minds it was impossible to arouse any particular kind of interest, no matter what subject was presented to them. Those students, in his view, should not be allowed to cumber the classes of the schools; they should be promptly turned out at a certain age, say, sixteen or something of that kind, and made to pursue some other useful employment, which would be much more satisfactory to themselves and more valuable to the community. That question ought to be faced at the present time, when things in general were being treated in a serious spirit, and he hoped it would receive more serious consideration than had been the case in the past. He noticed with much interest, a few months ago, the scheme put forward by Dr. Lyttelton, who had just left Eton, in which he provided a class for boys in which neither Latin nor Greek was taught; everything was to be English, with a little mathematics. That was the first attempt that had been made to deal, by a definite system, with the class of what it was impossible to avoid calling stupid boys. He congratulated the author on having made a move which, from the authoritative position he held, would have a good effect in modifying the extreme views of people on both sides.

DR. R. MULLINEUX WALMSLEY (Principal of Northampton Institute, London) thought the present crisis in the educational world was of no less importance than the crisis in the political world, and that the views enunciated in the paper would lead along the right path to a solution. He did not propose to speak from the scientific side, because, like the author, he thought there should be no antagonism between literature and science when the subject of education was being discussed. It was not what an individual learned that was the important thing, but how it was taught, how knowledge was acquired, and the influence of the teacher. One of the statements in the paper which appealed to him most deeply was the remark that, in order that our educational system might enter upon a new phase, it was necessary to attract into it the best intellects of the country, and that to do that the prizes in the educational world must bear some relation to the prizes in other walks of life. In that way the ideal teacher that the author indicated would be obtained, namely, *the* man. It was the man in the highest sense of the word that was required for educational work. Nothing would so influence the coming generation as the personality of the teachers in the schools, and unless that personality was obtained curricula, whether scientific or classical, were of no consequence whatever. He differed from Sir William Tilden's nterpretation of the Chairman's remark, that only the best boys in the school would arrive at the highest literary attainments taught in the school. Personally, he interpreted the Chairman to mean that only the best boys with the literary instinct would get that far, and that there were best boys in other directions. The best boys were not to be picked out because of their interest and their acquirements in a single side; it was necessary

to have the others as well. He had very much sympathy with the "submerged tenth"—he was afraid it was more than a tenth—to which Sir William Tilden had referred; and he had publicly stated on a previous occasion that there were certain boys and girls upon whom the money of their parents, the time of their teachers, and the accommodation of the class-rooms should not be wasted after they had acquired the three R's. They should be put to something else. It was perhaps rather hard on the boys, but those who came in contact with large numbers of them knew that there were in the schools boys who not only wasted the time of their teachers, but also kept back the classes. He was afraid that the paper had not given a solution to that problem, which he commended to the attention of all educationalists, because if that part of the problem was neglected the highest education in the schools would be impeded by that residuum.

Professor A. C. Seward, F.R.S. (Master of Downing College, Cambridge), thought, as the author truly said, that one of the first aims in education was to discover the aptitude of the student, and that often seemed to him one of the strongest arguments in favour of the suggestion that science should be taught to every boy in a school. Many boys who had not had the opportunity at school of learning any of the natural sciences had, on that account, largely wasted their time, and they had perhaps been classed as the "submerged tenth." There were a good many boys who for years during their school life appeared to have no particular aptitude for the ordinary school work, and yet in later life, after they had gone to the university perhaps, they suddenly discovered something in which they were really interested, and that was not infrequently some science subject. It was not because he desired everyone to be a scientific person that he advocated the teaching of science to all the boys in the school, but largely because by doing so there was more chance of discovering boys who had an aptitude for that particular branch of learning. It was often overlooked that success depended very largely indeed upon the personality of the teacher. He had often felt that the great aim of a teacher should be to make his pupils interested, a point that was frequently overlooked. A lecturer often worried as to whether he had sufficient facts for a lecture, but he frequently did not pay enough attention to the question of whether he was going to place the subject before the students in such a way that it would be interesting and real to them. If boys could be made interested in a subject they would do almost anything. The author had touched upon the question of science, as contrasted with literature or classical education, from the point of view of the effect upon the training of the imagination. In one or two of the statements the author had made he did not think sufficient credit had been given to science, more especially biological science, for the influence it had, if properly taught, on the spiritual side of a boy's life. The author spoke of science as being the study of material environment and as being to a certain extent rather materialistic, whereas other subjects tended to develop the other side of a boy's character. He felt a great deal of sympathy with the remark of a character in one of Meredith's books who said, "Men of science, my Cassandra, are always the humanest." Some of the most human people he had known were people who had been naturalists—not necessarily people who had the most minute or intimate acquaintance with any particular science, but people who had been brought up from their youth to love nature, who had been taught science at school, and who had gone on in after-life teaching themselves. He did not know any subject which, if properly handled and placed before students in the right light, was more likely to develop the good side of their nature. Some people held the idea that if a person knew anything about the structure of organisms, of a flower or an animal, they lost their æsthetic pleasure in it, but he was absolutely certain that was not the case. He did not mean for a moment to suggest that science could in any sense replace what a literary education could give, because he felt that anyone who was brought up on a scientific education, without due attention having been paid to a love of good literature, was only half developed. He thought the tendency was more and more noticeable at the present time not to push one subject, science or classics, as they were generally called, at the expense of the other, but that, as the author said, due attention should be given to both. He was very pleased the author had quoted the story about Canning, because it expressed the opinion he had often held himself, namely, that one came across so many people who professed to be ashamed of not knowing certain things. The late Bishop of London made a remark which it seemed to him was exceedingly true in that connection, namely, "Never be ashamed of not knowing, but be dreadfully ashamed of not wanting to know."

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Benson for his interesting paper.

Mr. A. C. Benson, in reply, after thanking the Chairman and the other speakers for the very kind way in which they had received the paper, said he desired to emphasise, in order that there should be no misunderstanding, the point which one speaker had brought out very clearly, that the whole object of the paper was that there should be no antagonism between the two sides. He agreed with Dr. Seward that science should be taught to all, because he thought there was a certain stage in the development of the human mind when concrete observation was alive, before the reflective powers came into full swing, when a child was inclined

to pull everything to pieces and ask questions, which parents found it so impossible to answer, partly because they did not know and partly because the questions themselves were unanswerable. Quite in the early stages, and up to the time when the roots divided, science should be taught to everybody, and an attempt should be made to make the mind more or less familiar with the whole range. When he was a schoolmaster at Eton he tried an experiment which seemed to him to be fruitful of great possibilities if it could have been further developed. He bought one day the entire stock of a newsvendor of a morning paper, gave a copy of the paper to each boy, and lectured on the paper as a whole—the weather reports, markets, and everything else. He knew enough of the subjects to teach the boys that the views of the world were making themselves heard through the paper, and showed them that, although it might be difficult to believe it, there were distinguished and intelligent people who, immediately they received the paper, hurriedly tore it open and looked first at the item that interested them, however dull and unintelligible it might appear to the boys. He wanted them to appreciate that the paper represented the life of the world; he wanted the growing boy to get some conception of the world, not only as it was seen and viewed, but as it was heard of in books. Dr. Seward had alluded to the imaginative value of science. Tennyson, as a boy, was very much devoted to astronomy, and when one of his brothers complained that he had been invited to tea at the neighbouring vicarage and that he felt shy, Tennyson said: "Why not try and think of the star clusters?" The brother tried to do so, but pronounced it a most colossal failure. When he was confronted with the circle of faces round the tea-table at the vicarage, no amount of turning the mind on to star clusters and constellations was of the slightest help; it only made him feel more shy than before. Lord Bryce had inquired whether classics were to disappear in the scheme that had been suggested. They would not, according to his theory. As a matter of fact, Latin was probably certain to hold its own for the present, although personally he did not think it was a very good subject to keep. It was supposed to be a good mental training, and to be the basis of many other tongues; but if the object of education was to teach the other tongues, why not teach them instead of the basis? The real difficulty about Latin was that Latin prose which was suitable for amateur minds was practically non-existent, whereas, so far as Greek was concerned, the "Odyssey" had been taught to many generations of boys, and he had seldom known any who had not been touched to a certain extent by the finest and greatest story in the world. The "Cyropædeia" was also an excellent book from which to teach Greek to boys. There was nothing like that in Latin at all. Cicero and Cæsar were the mediums generally employed, and he personally felt that Cicero was singularly calculated to disgust the intellectual processes of the youthful mind. Cæsar was a hard, compressed, rather rhetorical commentary on the most minute military operations; one moved slowly through a kind of dim light without any idea of what it was all about, reminding one of the hymn—

". . I do not ask to see
The distant scene; one step enough for me."

Lord Bryce suggested to him that Cornelius Nepos might be taught, and that was a possibility, but he thought there was a singular tenuity in the lives of Nepos. He was very grateful to his lordship for emphasising so strongly the object of education—the habit of observation, intellectual curiosity, reflecting upon what one saw, and making knowledge delightful to the mind. That was what they were aiming at, and that was what he believed an education based, to a certain extent, on the principles he had attempted to enunciate might do—*i.e.* an education with a broad sweep, not neglecting anything, with no antagonism, but merely attempting to acquaint the minds of the boys whom they wished to educate with the world as it lay about them, the history of the human spirit, and some outlook upon the future which would make the human race brighter and better instead of more complicated and dim.

THE HURTER AND DRIFFIELD MEMORIAL FUND.

The Royal Photographic Society have appointed a committee to collect subscriptions for a memorial to Messrs. Hurter and Driffield, whose researches did so much to advance both the science and practice of photography. As their work is little known to the very numerous public who now practise photography, some account of it may be interesting. Dr. F. Hurter (who was of Swiss nationality, and was born at Schaffhausen) died in 1898 and V. C. Driffield in 1915.

Hurter and Driffield studied for many years with great thoroughness the quantitative relationships between causes and effects in the various processes employed in the making of a photographic negative. They showed by measurement with simple photometric apparatus that the amounts of silver reduced on development of a sufficiently exposed plate are proportional over a reasonable range to the logarithms of the exposure products (intensity × time), and from this deduced their well-known methods of determining the speed of photographic plates.

Much valuable work was also done on the influence of the composition and time of action of developers, and the results obtained by them have been of very great value to photography. Without the powers of quantitative examination and exact definition of the qualities of plates put in the hands of the manufacturers by Hurter and Driffield, the English dry plate

manufacture would never have attained the excellent position it holds to-day.

The conclusions Hurter and Driffield drew from their researches have, as a whole, well stood the test of later and more critical examination, and the stimulus they gave to the scientific study of photographic problems has resulted in the growth of a new branch of scientific inquiry for which many laboratories are specially equipped, and which no manufacturer of photographic dry plates can now afford to neglect.

The committee ask for funds to enable them to carry out the following objects :—

1. The endowment of a Hurter and Driffield Memorial Lecture.
2. The provision of suitable accommodation for the apparatus and manuscripts bequeathed to the Society by the late Mr. Driffield ; and
3. The publication of a book containing the collected papers of Hurter and Driffield.

The hon. treasurer of the fund is W. B. Ferguson, Esq., K.C., 48, Compayne Gardens, South Hampstead, N.W.

NOTES ON BOOKS.

DISCOVERY ; OR, THE SPIRIT AND SERVICE OF SCIENCE. By R. A. Gregory. Macmillan & Co. 1916.

Mr. Gregory states that his object is "to promote a more sympathetic attitude towards those who are engaged in the pursuit of scientific truth" and "to remove the widespread misconception which prevails as to the meaning and influence of science." Surely, however, the case is not quite so bad as all that ? Scientific men have no great cause to grumble at the way they are treated nowadays, and the prevalent misconception about the powers of science is probably to overrate them.

There is, however, no doubt that scientific men, as such—men who devote themselves to pure science—do not get the same amount of public distinction, or acquire the same amount of wealth, as men who successfully devote themselves to law, medicine, the church, politics, or other means of acquiring profit or renown. There are but a small proportion of scientific peers, Privy Councillors or baronets, and even the initials tacked to the names of "scientists" indicate more often association with societies and universities than with knightly orders. Even in America the scientific millionaire is as yet unknown. But, after all, men make money by supplying their fellow-creatures with services they desire. They cure their diseases, they prosecute their law cases (either protecting them from nefarious attacks or averting the consequences of nefarious performances), they write them the sort of books or paint them the sort of pictures they prefer. You may render your fellow-men the greatest services you like, but if they are not the services they require you will get neither cash nor credit. So must it be with men of science. They must submit to actualities. If they want money, and the various distinctions which follow on its possession, they must devote their talents to practical purposes. If they prefer to devote them to the advancement of human knowledge, they must be satisfied, like many of the greatest students, authors, poets, painters and philosophers, to work for no pay and limited appreciation.

It really, therefore, may be doubted whether there is a very urgent need for an appeal on behalf of down-trodden and neglected science. But if such an appeal is to be made, there could be nobody better qualified to make it than the assistant-editor of *Nature*. For many years he has had to deal with every branch of scientific knowledge and to record every advance made in it. And he has made good use of his opportunities, for he has collected together a very considerable number of illustrations, mainly historical, anecdotes, records, and examples, all interesting, and nearly all, so far as a somewhat cursory inspection justifies opinion, quite accurate. His evidence is unimpeachable, but his conclusions are very much open to argument. In the familiar words of the "Evidences," it may be true enough that many have "passed their lives in labours, dangers, and sufferings . . . in attestation of the accounts which they delivered," but it is equally true that many others have turned their scientific knowledge to very practical account, and have acquired by its wise application large and well-deserved emolument. Nobody would go about saying that scientific research had conferred no benefits on humanity ; but with all her beneficent influence it is not to be denied that science, like religion, is responsible for an infinity of human pain and anguish. The past two and a half years provide evidence enough of that.

Assuredly also nobody would want to stop scientific progress because among its results are included aeroplanes, submarines, and high explosives as well as anæsthetics and radiography. But unreasonable laudation rouses antipathetic depreciation, and if we are to have a record of the "spirit and service of science" the case ought to be fairly stated. But perhaps we ought to remember that Mr. Gregory does not pose as a historian or as a judge, but as an advocate, and we must not expect judicial impartiality in counsel's speech for the prosecution. The pity of it is that nobody is likely to accept a brief for the defence, so we shall never hear the other side.

At all events the author has produced a book of an original and attractive character. It contains a great deal of interesting matter, and students of the history of science may read it with much profit and advantage.

THE CANNING OF FRUITS AND VEGETABLES. By Justo P. Zavalla, M.S. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 10*s.* 6*d.* net.

In the earliest attempts to preserve fruit, vegetables and meat, it would appear that glass was universally employed for the containing vessels, but in 1825 Thomas Kensett secured a patent for the use of tin cans, and he at once began to make them in his factory. Since that time the use of cans has increased to such an extent that now, as Mr. T. F. Hunt says in the introduction to this volume, "human beings may be traced in almost any part of the globe through the cans which they leave behind them."

The art of canning fruits has probably approached nearer to perfection in California than in any other country. Mr. Zavalla, the author of this book, is a graduate of the College of Agriculture of the University of California; he has himself contributed considerably to the study of the preservation of fruits and vegetables, and in this work he embodies a vast amount of scientific and practical information on the subject.

The volume is divided into four parts. The first deals with fruit canning, and describes the methods of purchasing the fruit, of receiving it in the factory, of selecting and preparing it, the various ways of peeling and slicing it, and grading it according to quality. The canning department is next dealt with, the preparation and grading of the syrup, exhausting, processing and cooling, and finally the machinery for canning and can-making.

Part II. similarly deals with the canning of vegetables, especially asparagus, beans, cabbages, cauliflowers, corn, peas, and tomatoes.

In Part III. micro-organisms and spoilage are treated. The methods for the bacteriological and microscopical examination of spoiled canned foods, and the apparatus required therefor are fully described, and there are various valuable sections on moulds and yeasts. The subject of the fourth part is the making of sanitary cans.

The book is illustrated by numerous diagrams, both of machinery and of putrefactive micro-organisms, and provides a very excellent account of a great and growing industry.

GENERAL NOTES.

MARTELL SCHOLARSHIP IN NAVAL ARCHITECTURE.—A scholarship, designated the "Martell Scholarship in Naval Architecture," will be offered for competition by the Council of the Institution of Naval Architects. The scholarship is of the annual value of £100, and, subject to the conditions named below, is tenable for three years: (1) Candidates for the scholarship must forward a written application to the Secretary of the Institution of Naval Architects, 5, Adelphi Terrace, London, W.C., to reach him not later than January 15th, 1917: (2) Candidates are not to be less than eighteen nor more than twenty-one years of age on March 1st, 1917, and must at that date have been continuously employed for at least two years upon naval architecture or marine engineering; (3) the scholarship will be awarded in connection with the competitive examinations for scholarships, studentships, etc., to be held by the Board of Education in May and June, 1917, in the following subjects:—Naval architecture; pure mathematics; applied mechanics (materials and structures); either (*a*) applied mechanics (machines and hydraulics), or (*b*) heat engines.

IRON INDUSTRY AT CAEN.—The iron mines and blast furnaces of Caen (Normandy), after having been in a languishing condition for many years, are once again most flourishing. In 1900, during the period of greatest stagnation, the production of the local mines reached only about 142,000 metric tons of iron ore, as compared with 12,000,000 metric tons produced by Lorraine, though the Normandy ore is richer than the other. In 1909, according to a report by H.M. Consul-General at Havre, the German Thyssen interests obtained a foothold in the industry, and thenceforward considerable German and Dutch capital was invested therein. On June 1st, 1914, the number of mining concessions was twenty-one, of which twelve were being fully worked, producing annually 750,000 metric tons of iron ore. New plant of the most modern and powerful kind is being installed, and the railway authorities are doing everything in their power to assist the development of the industry. The output of iron ore in this district has now reached over 1,000,000 metric tons annually.

TOBACCO IN NEW ZEALAND.—Some particulars are given by H.M. Trade Commissioner in New Zealand of the cultivation and manufacture of tobacco in New Zealand by a syndicate which possesses a tobacco plantation at Clive Grange. Since operations were begun three years ago the company has raised three crops, partly under most unfavourable weather conditions, last season's crop having had practically no rain. The nine months of drought experienced in that year had no adverse effect on the tobacco crop, and it did not suffer from blight or pest. The New Zealand grown leaf is said to contain hardly 1½ per cent. of nicotine, which compares favourably with American-grown tobacco. Among the classes of tobacco produced by the company are plug, flake, long cut, bird's eye, and shag. British firms interested may obtain further particulars on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, London, E.C.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 3rd, 3 p.m. (Juvenile Lecture.) Mr. ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications."

The lecture will be fully illustrated with numerous experiments.

Special tickets are required for the Juvenile Lectures, and no person can be admitted without one. A few tickets are still left, and these will be issued to Fellows who apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, December 14th, 1916. The RIGHT HON. LORD EMMOTT, G.C.M.G., took the chair at the commencement of the proceedings.

THE CHAIRMAN, in introducing Professor Todd, asked to be allowed to depart from the usual custom and to say one or two words himself in advance. He regretted that other engagements, new since the time when he promised to preside, made it necessary for him to leave the meeting at once. He would, therefore, be unable to have the pleasure of listening to what he knew would be an extremely interesting paper, and he apologised to Professor Todd and to his audience for running away as he would have to do. Perhaps, however, they would permit him in the circumstances to say one or two words about the subject of the paper. He entirely agreed with the author that India was probably the only country in the world to which we could look for a great and rapid increase in the production of cotton such as was essential for the industries of the world. From the Lancashire point of view he might add that unless the quality of cotton coming from India could be enormously improved, the relief to the general situation which an increase of the crop in India would bring about would not accrue, at any rate, principally to Lancashire. To put it in an unscientific way, cotton seemed to him to be one of those commodities which took its permanent character rather from the soil and climate in which it was produced than from the seed from which it was originally grown. Of course, it was the business of men to overcome difficulties of that kind, and it was their business from every point of view to do whatever was possible to improve the quality of cotton grown in India. Putting it generally, unless we got cotton an inch or over in staple, with good, even running, year after year, it would not bring relief to the industries of Lancashire, whatever it might do to other parts of the world. The question was really of vital importance from the point of view of the industries of this country and of the Empire at large, and there was no question more deserving of careful and intelligent study and experiment. There was no one more capable than Professor Todd of speaking on this subject, for he was at present Professor of Economics at University College, Nottingham, and had been, previously, Lecturer in the Khedivial School of Law at Cairo, and last winter Special Lecturer on Economics in the Punjab University at Lahore. Therefore, he had had special experience of the matter with which he was going to deal.

[With a further apology for having to leave the meeting Lord Emmott then withdrew.]

SIR WILLIAM DUKE, K.C.S.I., K.C.I.E., then took the chair, and called upon Professor Todd to read his paper.

The paper read was—

THE WORLD'S COTTON SUPPLY AND INDIA'S SHARE IN IT.

By John Aiton Todd, B.L.,
Professor of Economics, University College, Nottingham.

The question of the world's cotton supply has again become extremely acute. On November 20th last the spot price of American Middling in Liverpool touched 12·59*d.* per lb. Less than twenty years ago the price was under 3*d.* per lb.; before the war it was over 7*d.*, while just two years ago it touched 4·25*d.* The present price is the highest recorded since 1869, when the cotton world was still suffering from the aftermath of the famine due to the blockade of the Southern ports during the American Civil War. The present position is, however, markedly different from that of the sixties. The high prices then prevailing were due to an artificial scarcity caused by the difficulty of getting cotton through the blockade. To-day's high prices are the result of natural and economic causes, which may quite well be repeated if the conditions of supply are allowed to remain as at present, and the question of how these conditions are to be improved is not merely of world-wide general interest, but also of special interest to the British Empire and particularly to India.

To make the present position clear, it is necessary in the first place to outline the essential facts which have given rise to it. These are briefly as follows:—

1. The world's demand for cotton has been increasing rapidly for the last fifteen or twenty years, and though the world's crops have also been increasing (see Table A in the Appendix) the actual consumption during recent years has only been limited by the supply. During the ten years before the war the year's consumption was actually in excess of the world's supply in five out of the ten. This is clearly brought out in Table B, which shows the world's commercial crops and mill consumption during these ten years, while it also brings out the very close relation between each year's excess or deficiency of supply and the world's prices of cotton during the corresponding season. It is, unfortunately, impossible to carry these figures on through the years since the war; but similar figures are given for the American crop alone which bring out a corresponding result since 1914.

2. The cost of production of cotton, especially in America, which still dominates the world's supply, has been increasing rapidly during recent years. In 1913 the writer, in the course of a tour which covered practically the whole of the American Cotton Belt, went very carefully into this question, and came to the conclusion that, unless the price of Middling American in New Orleans is round about 12 cents per lb.,* the field price of cotton is not sufficient to remunerate adequately the average planter in Texas, especially the white planters, who are more numerous there than in any other part of the Belt. The Texas crop, which in 1912 almost touched 5,000,000 bales, is about one-third of the whole American crop and one-fifth of the whole world's supply, and during the years 1903–13 Texas alone made 53 per cent. of the total increase in the acreage under cotton in America. The Texas crop is, therefore, indispensable to the cotton world, and the cost of production in Texas, which is admittedly higher than in any other part of the Cotton Belt (except perhaps the small areas in Arizona and California, where a superior quality of cotton is grown), must be covered by the world's price.

3. The slump of cotton prices in the autumn of 1914, due to the war, hit the growers very hard. Cotton sold in the districts at as low as 6 cents, and would probably have gone even lower but for the unexpected holding power which the planters as a whole displayed. Their financial position, aided by the improved banking system of the Federal Reserve Banks, proved much better than was commonly expected. At the same time, the difficulty of finding storage accommodation for a material proportion of such a record-breaking crop proved less insurmountable than was thought likely. The result was that prices remained relatively high, considering the huge crop (estimated at 17,000,000 bales actual, though only about 15,000,000 came into sight during the season) and the hopeless slump in the demand which marked the first few months of the war. When it is remembered that in 1911–12, with a crop of only 16,043,000 bales, Liverpool prices went below 5*d.*, though only for a very short time, the official minimum of 4·25*d.*, which was touched early in December, 1914, is seen to be quite reasonable. Unfortunately, however, this official minimum did not represent the level to which the actual prices fell. In the Cotton Belt, field prices were such as to discourage planters very seriously, with the

* For details see "The World's Cotton Crops," by the writer (A. & C. Black, 1915), p. 112.

natural result that the 1915 acreage was considerably reduced. The final estimate, which was not published until June, 1916, was 32,107,000 acres, as against 37,458,000 in 1913, and 37,406,000 in 1914, and the effect of this reduction of 14 per cent. in acreage was accentuated by the marked reduction in the use of fertilisers for the 1915 crop. The inevitable effect upon the crop was shown by the reduction of the *Chronicle's* figures of the outturn to 12,953,450 bales, against 15,067,247 in the previous year, and it is probable that the relative amount of these two figures would be considerably altered if it were possible to estimate how much of the 1914 crop did not come into sight until after the opening of the 1915-16 season.

4. Following upon this serious reduction of the 1915 supply there came a marked recovery in the demand throughout the world. Our own home trade was probably never better. The demand for linters for gun cotton is very difficult to estimate, but the writer's guess of 1,000,000 bales, which was questioned at the time, is now probably below the mark. The marked expansion of the cotton industry in America and Japan, and probably also in India, was perhaps the chief factor in the increased consumption, and the extent of this may now be estimated from the fact, only recently confirmed by official figures, that the consumption of cotton in America during the season 1915-16 was fully 7,250,000 bales, as against about 5,000,000 bales a few years ago. The result was that the lean year of 1915 ate up a very large portion of the surplus of the fat year of 1914, thus adding another pair of years of alternate excess and deficiency to the ten before referred to.

5. These facts were not realised early enough to put up the price during the winter of 1915-16, and so tempt a record acreage for 1916. Prices in New Orleans were much oftener below than above 12 cents during the winter, and they fell markedly from January to the beginning of March, which is, of course, the most critical period. In the end of February, 1916, the New Orleans price touched 11·13 cents. The effect upon the 1916 crop was a foregone conclusion. The acreage under cotton in America was only moderate, the revised estimate being 35,239,000 acres, or fully 2,000,000 below the record.

6. Unfortunately the course of events in America was paralleled by the conditions in Egypt and in India, and probably throughout the other cotton-growing areas of the world, with perhaps the exception of Russia. The Egyptian Government early in the autumn of 1914 adopted a policy of severe legislative restriction of the 1915 area, which, in the light of subsequent events, can only be described as panic-stricken. As a matter of fact the restriction became a dead-letter, and had to be officially withdrawn early in the spring of 1915, but it at least helped to bring about the very serious reduction in the acreage in Egypt, which amounted to nearly 33 per cent., the acreage being reduced from 1,755,270 feddans to 1,186,004. In India the Government early in the winter had contemplated similar restrictive measures; but these were not pressed, and, indeed, were probably not given effect to at all except in one or two districts. But the economic conditions were sufficient of themselves to produce the same result on the acreage in India, and the actual reduction proved to be nearly 27 per cent., namely, from 24,595,000 acres to 17,967,000.

In 1916 the prospects of the Egyptian crop were early in the season described unofficially in a way which could only be characterised as unduly optimistic. The record acreage of 2,000,000 feddans * and a bumper crop of 8,000,000 kantars were unofficially forecasted; but, unfortunately, these estimates were speedily falsified. The official report of the acreage proved to be only 1,655,512 feddans, being 6 per cent. less than that of 1914. In India it is not possible yet to give any estimate of the full 1916 acreage, but the official figures so far issued show only an increase of 12 per cent. on the figures of 1915, and are, therefore, much below pre-war records.

7. The table given on page 112 summarises these statistics and leads up to the inevitable conclusion. As the season of 1916 advanced, the cotton world began to realise that the prospects of supply were none too good, while the demand was proving beyond all expectation, and it became evident that unless the weather during the growing season remained favourable the expected supply would be barely enough to meet the expected demand. When to this was added the probability of the war coming to an end before the close of the 1916-17 season (July 31st, 1917), it was brought home to the trade that the position of the supply was precarious in the extreme, and that if anything should go wrong with the American crop the supply would be seriously short. As thunder follows lightning, the facts followed this realisation. The weather in America during the summer was just about as bad as it could

* A feddan is roughly an acre and a kantar 100 lb.

ACREAGE YIELD AND PRICES OF THE WORLD'S CHIEF CROPS, 1913-17.

Season.	Acreage.	Per cent on 1913.	Crop.	Yield per Acre.	Liverpool Prices (pence per lb.). Lowest.	Highest.	Average.
American.	Acres.		Bales—500 lb. approximately.	Bales.		Middling.	
1913-14	37,458,000	--	14,609,968	·39	6·20	7·96	7·26
1914-15	37,406,000	100	15,067,247	·40	4·25	6·50	5·22
1915-16	32,107,000	86	12,953,450	·40	5·34	8·74	7·51
1916-17	35,239,000	94	*12,500,000*	·36	5·42*	12·59	—
Indian.	Acres.		Bales—400 lb.†	lb.		No. 1 Fine Oomra.	
1913-14	25,020,000	--	5,065,000	81	4·70	6·56	5·87
1914-15	24,595,000	98	5,209,000	85	3·94	5·00	4·46
1915-16	17,967,000	72	3,819,000	85	4·75	6·90	6·09
1916-17	*20,000,000*	80	*4,500,000*	*90*	4·75*	9·40	—
Egyptian.	Feddans.		Kantars.	lb.		F. G. F. Brown.	
1913-14	1,723,094	—	7,684,172	444	8·15	10·45	9·44
1914-15	1,755,270	102	6,346,768	362	6·30	8·30	7·34
1915-16	1,186,004	69	4,605,437	386	7·50	11·90	10·42
1916-17	1,655,512	96	*6,000,000*	*364*	7·50*	21·85	—

The figures in *italics* are estimates.

* To December 1st, 1916. † See note on Table A as to Indian Government estimates.

be for the cotton crop, and the third of the Government condition reports (as at July 25th) showed such a falling-off from the second as to produce something bordering on panic. Prices began to rise rapidly. The 9*d.* limit was passed in the last week of August, and the shilling on November 17th, and the crisis which had long been predicted by a few so-called pessimists had become an accomplished fact. The world was caught hopelessly short of cotton.

For this serious state of affairs there is practically no remedy as far as the present season is concerned, except perhaps to restrict the necessary consumption as far as possible. The world's cotton crops are almost entirely grown in the Northern Hemisphere, and, therefore, during our summer season. With the exception of South India, Peru and Brazil, they were all sown before the present high prices began, and there is nothing for it but to wait till next year for an increased supply. Then we shall surely have a record acreage in America again, and, with ordinary luck in the way of weather, we should have a bumper American crop next season, which ought materially to relieve the situation, especially if the war drags on through next summer, and there is still no definite date in sight for peace when the new crop begins to come in. But surely the bitter experience of this season ought to be enough to drive home finally the dangers of our being so largely dependent on the American crop for the world's supply of cotton. These disadvantages have often been pointed out, but they may be restated in the light of this new experience as follows:—

(1.) The American crop is no longer able to keep pace with the increase of the world's demand. That is the new feature of the situation to-day. The American area has stopped increasing since 1913, and it is an open question whether, or rather at what price, it will begin again. That it will touch new records again in acreage and quantity is hardly to be doubted, but only at a price that will cover the high cost which now rules the production of cotton in Texas. The war has proved that the South has much greater facilities for diversification of its crops than was generally known, or than was ever true before. The labour difficulty is constantly increasing. The boll-weevil, whose depredations do so much to reduce the profit earned on cotton-growing, is extending its area rapidly north-eastward through the

Atlantic States, and is adding every year to the difficulties and uncertainties of the crop. For it must be remembered that cotton is essentially a speculative crop from the planter's point of view. He never knows in any season what his money yield per acre will be, because it depends in the first place on the weather and the boll-weevil, and secondly on the world's price, over which he seems to have no control. There are, therefore, many planters always ready to go off cotton for a season to a greater or less extent, and only a very high level of permanent prices will again induce the planters, as a whole, to resume the steady increase of cotton acreage which had been maintained for some years before the war.

(2.) The high cost of production of the crop is militating strongly against the continued increase and permanent supremacy of the American crop. This is largely due to the rising cost of labour, which is likely to be maintained, if it does not go on increasing. Cotton has always been regarded as a cheap labour crop, and labour in the Southern States is no longer cheap. America, therefore, has lost one of the advantages which made it an ideal cotton country, and there are now many other countries which, on account of their cheaper labour supply, are better fitted for cotton-growing than America.

(3.) The American crop has developed a sort of regular irregularity or periodic fluctuation in its outturn, which is a very serious fault in the raw material of a great industry. The writer's investigations into the recent history of the crop have brought out the fact that there is a well-established vicious circle in the relation between area, crop and prices, thus: The effect of a large crop in any one year is naturally to reduce the world's price for that season. This discourages the planters, and leads to a reduced acreage in the following year. Thus it will be seen from Table C in the Appendix that there is a very close correlation between the area sown in any year and the price of the previous season, which, of course, is only natural, though its full effects have perhaps not been noted before. The result is to confirm in a way the old Lancashire saying, that a big crop is always followed by a small one, and *vice versâ*. There is a tendency to a see-saw or pendulum movement in the crop from year to year, which is very undesirable from the point of view of the manufacturers, especially in an industry where goods are sold so far ahead as they are in the cotton trade. The strength of this tendency in America is largely due to the fact that many of the planters are working so near the margin of profitable cultivation.

(4.) In addition to this periodic variation of the supply, the amount of the American crop from year to year is rendered still more uncertain by its complete dependence upon the American climate, which is most variable, and which affects the crop adversely or otherwise throughout practically the whole length of the year. Thus the most promising crop may be ruined at an advanced stage of its growth by unfavourable weather conditions, as the 1916 crop has been, and this introduces a further and most undesirable element of speculation into the quantity, and therefore the price, of the crop. (See the fluctuations of the yield per acre in Table C.) The only way to minimise these fluctuations of the price is to develop a much more considerable bulk of the world's cotton supplies in some area entirely removed from the American Belt, where the climatic variations, even if they are no less extreme than those of America, will at least be different, so that all the world's crops are not likely to be affected in the same way in any one season.

All this points to the desirability of developing other sources of supply of cotton outside of America. If at the same time such a supply can be obtained in some other continent, where the labour cost is not so high as it has now become in America, so much the better. Finally, if such a crop could be found somewhere in the British Empire, it would, from our point of view, be the greatest advantage of all. Is such an increase of the supply possible?

To answer this question it is necessary to enter upon a rapid survey of the present sources of the world's cotton supplies. Instead of making the survey in geographical order, it may be more easily followed if taken instead in order of the quality of the world's chief cotton crops. For this purpose the writer has always found it convenient to divide the world's principal varieties of cotton into five grades, into which the recognised trade classifications are grouped. The best cotton of all is the true "Islands" cotton, which is the very best Sea Island cotton, and is only grown in certain small islands off the coast of South Carolina near Charleston and in the West Indies. The total amount of this crop is exceedingly small and its value very high, as much as five or six times the basis price of American Middling being paid for the best "crop lots." It will be seen from the table given on page 114 that the crop is divided between these two sources of supply

in the proportion of one-third from the British Empire and two-thirds from the other source. The same principle of classification is followed out in the table with regard to the other grades. The second grade, also called generically Sea Island, is known as Floridas and Georgias. In this grade may also be included the best Egyptian varieties—Sakel, Jannovitch and Abbassi. The third grade includes ordinary Brown Egyptian, and the best of the long-staple American cottons, while Peruvian cotton comes pretty close to it, and even some of the Nyasaland and Uganda cottons are not far behind, though perhaps more properly placed in the next grade. In both these grades the Empire's share stands very high. The fourth grade is the great bulk of the world's supply, the American crop forming by far the greater part of it, and it will be seen from the table that it is in this grade that the British Empire stands worst; for all that we can show in this class of cotton is a comparatively small amount, say 15,000 bales from West Africa, and that part of the Indian crop which is above the usual Indian quality, and which amounts now to between 250,000 and 500,000 bales. But practically all our rivals are better placed than ourselves in respect of this class of cotton. Russia has a crop of a million bales within her own borders, Germany a crop of 100,000 bales in the Levant under her control, and even Japan has a considerable supply of fairly good cotton of American quality at her own doors in China and Corea. Finally, in the fifth or lowest grade of cotton, the short-stapled native Indian varieties, we again have the enormous but undesirable preponderance; for the Indian crop forms the greater proportion of the total of this class of cotton in the world.

Our position, therefore, is that we stand well in comparison with other countries in respect of our Imperial supplies of the best and the worst grades, but that we are almost entirely

THE WORLD'S COTTON SUPPLY, AND THE BRITISH EMPIRE'S SHARE IN IT.

Grade.	Quality and Staple.	Where Grown.	World's Crops. Bales.	Empire's Share.	Per cent.
I.	*Best Sea Island*	Islands, South Carolina	10,000		
	(Longest Staple)	West Indies	5,000		
			15,000	5,000	33
II.	*Second Grade Sea Islands*	Florida and Georgia	70,000		
	(Long Staple)	West Indies	2,000		
	Best Egyptian (Sakel, etc.)	Egypt	430,000		
			502,000	432,000	86
III.	*Egyptian*	Egypt	1,000,000		
	(Good Staple)	Sudan	25,000		
	Staple American	Mississippi Delta, etc.	200,000		
		Nyasaland, Uganda, and East and South Africa.	50,000		
		Peruvian	125,000		
			1,400,000	1,075,000	77
IV.	*American*	U.S.A.	15,000,000		
	(Ordinary Staple)	Mexico	150,000		
		Brazil	300,000		
		Russia	1,000,000		
		West Africa	15,000		
		Levant	100,000		
		India	250,000		
		China and Corea	250,000		
			17,065,000	265,000	1·6
V.	*Indian*	India	5,000,000		
	(Short Staple)	Russia	400,000		
		China	1,800,000		
			7,200,000	5,000,000	69
			26,182,000	6,777,000	26

dependent on foreign sources for our supply of the " bread and butter " grades, which still form the great bulk, though not perhaps the highest value, of our consumption. Is there then any immediate possibility of our being able to remedy this defect in our position?

Passing over those of our Colonial possessions whose quality places them in the three higher grades of cotton supply, we come at once to Africa and India as the only parts of the Empire which might supply this deficiency. The Egyptian crop is far too good in itself, and far too valuable to our fine-spinning industry, to allow of its being replaced by anything approaching American cotton. The same applies to the Sudan, which is mostly capable of growing good cotton of Egyptian type, and it would be waste to put it into anything of a lower grade. There are, however, certain areas in the Southern Sudan which would probably be very suitable for growing cotton of the long-stapled American type; but it is quite certain that the development of these areas will have to wait upon the completion of schemes intended to benefit the other areas, and that alone will take a good many more years than we can afford to contemplate in our present survey. It will be ten or fifteen years at least before the possibilities of the Northern Sudan, including Tokar and the Gezirah scheme near Khartoum, will be anything like fully developed, and any possibility of developing the other regions in the grain-growing districts of the Southern Sudan must be postponed to that.

In Uganda, again, there are great possibilities; but the difficulties of communication and labour supply, which are the great stumbling-block to the development of all our interior African Colonies, will probably prevent any really great development there for a good many years to come. The largest crop yet reported was that of 42,000 bales of 400 lb. in 1914, and there is no likelihood of that figure being even doubled in the immediate future. Similar difficulties are delaying progress in Nyasaland, where there can be no question of the possibilities of the country, but much will require to be done in the way of improving railway and river communications before the present crop of less than 10,000 bales per annum can be materially increased.

There is only one part of Africa to which we may look for a really large increase of ordinary cotton, namely, West Africa. The magnificent pioneer work of the British Cotton Growing Association there, as well as in the other African Colonies already mentioned, has proved the possibilities of the country beyond doubt. But the provision of communications and the gradual opening up of the country is slow work, requiring a great deal of time and money, and the rapidity of progress has hitherto been checked by the fact that the local variety of cotton was just not quite good enough to make a really conclusive comparison, from the point of view of the grower's profit, with other competing crops which have the great advantage of requiring less care and labour for their cultivation. The African native is wise in his day and generation; his needs are few and very easily satisfied, and he is not easily tempted into the growing of crops which make serious calls on his limited energy. His food crops are easily grown, and he grows just enough cotton to make his own clothing, which is not over-abundant in quantity. But within the last year the situation seems to have changed very markedly in Northern Nigeria owing to the introduction of a new variety, which gives a much better return because of its higher yield and ginning outturn, and better quality, and which, therefore, seems to have caught on remarkably with the natives, with very encouraging results. The area available in Northern Nigeria is immense, and it may be hoped, now that the corner has apparently been turned, that future development will be much more rapid. It would be self-deception, however, to pretend that there is any prospect of a really large immediate increase of the supply from this country which would make an appreciable difference in the present position of the cotton industry. What the world wants is a progressive increase of something like a million bales per annum, and there is no possibility of such an increase being obtained from Nigeria, or indeed from any part of Africa, within the next ten or fifteen years at the least.

It is, therefore, to India that we must turn as the only hope for relief in the way and to the extent which the cotton industry requires so urgently.

India suffers sadly from her evil reputation in the matter of cotton-growing. Everyone knows the old story of the alleged prayer during the cotton famine in the sixties for " more cotton, but not from Surat," and ancient as the story is, it still represents the feelings of most people in Lancashire. They cannot believe that any good cotton can come out of India. Unfortunately this belief has its counterpart in India. Just as everyone in Lancashire

will tell you that it is no use trying Indian cotton, it is always short in staple and in very dirty condition, so most people in India will tell you that there is no use in their trying to grow superior cotton, because no one will buy it from them, especially Lancashire. But what are the facts? India to-day is growing from 250,000 to 500,000 bales of very fair cotton, similar to American in quality and of nearly an inch in staple, sometimes more, which is quite fit to be used in Lancashire, and which is, as a matter of fact, very largely used both in India and in Japan at the present time in place of American. As a matter of history the evil reputation of Indian cotton is of comparatively modern growth, and practically dates from the beginning of the nineteenth century. Up till about 1820 India actually supplied the bulk of the Lancashire cotton consumption, and it was only when the American crop began to increase rapidly and to find its way into England in large quantities that the Indian cotton began to be displaced. From the first, however, it is interesting to notice that one of the chief advantages claimed for the American cotton was its greater freedom from dirt and foreign matter, due to the method of ginning it or separating the lint from the seed. Ever since 1793, when Eli Whitney invented the saw gin, that alone has been used in America (except for Sea Island and other long-stapled cottons), while India has persistently adhered to modified forms of the old churka or roller gin, though, as a rule, it is no longer operated by hand. It is one of the puzzles of the cotton industry that, whereas in America it is impossible to persuade the trade that the saw gin is likely to harm good staple cotton, and should not be used for anything much above an inch in staple, all over India it is universally held that the saw gin "gin-cuts" even the short-stapled Indian cotton. This is not a mere matter of unsupported opinion, for as a matter of fact some of the Dharwar-American type of cotton grown in the Punjab was saw-ginned at first, and was rejected repeatedly by the Karachi and Bombay dealers as gin-cut, and samples of American cotton from Sind, which the writer himself saw in the Punjab last winter, certainly did seem to be badly spoilt in that way.

Saw gins are only used to any extent to-day in India in the Dharwar district, where presumably, like the local Dharwar-American cotton, they are a relic of the introduction of American seed and methods in 1840; but even there they are now being replaced by the ubiquitous roller gin. The only opinion the writer can hazard on the question is that the ginners in India do not know how to get the best results out of a saw gin; and that is by no means unlikely, judging from his experience (at secondhand, of course) of the difficulty of getting the best results out of the roller gin in Egypt.

This question is of more importance than it seems, because it is largely the question of the condition of Indian cotton that tells so strongly against it in English markets, and that is chiefly a question of ginning methods. The inferiority of the staple is, however, a more serious matter, and this question, too, is by no means new in India. To begin with, there is the ancient tradition of the Dacca muslins, which were made in India from cotton grown and spun in the country, though the writer was unable to find out where the cotton is supposed to have been grown, and what has become of the particular variety of the plant that produced it. But the allegation is frequently made that cotton as fine as 300's, or as fine as the best products of the Lancashire mills to-day working on the best Sea Island cotton, was habitually produced in India long ago. Even allowing for the exaggeration of tradition, it is difficult to reconcile this statement with the fact that the great bulk of the Indian cotton to-day is only about $\frac{3}{8}$ in. to $\frac{5}{8}$ in. staple. That, however, is by no means the best that India can do, even to-day, and in every generation there have been a few enthusiasts who have retained their belief in the possibilities of improvement of Indian cotton, and have struggled against great difficulties to prove the faith that was in them. Thus in the forties of last century, under the auspices of the East India Company, great efforts were made to introduce superior varieties into India, especially in Dharwar; and these efforts met with such success that to-day the descendants of these Dharwar-American cottons are still among the best cottons in India, and have recently become the parents of many new varieties such as the Punjab-American cotton. Again, during the cotton famine of the sixties, strenuous efforts were made in various parts of India by the Manchester Cotton Supply Association to increase the quantity and improve the quality of the Indian crop; but their success, though very encouraging, was not sufficient to outlive the subsequent depression of cotton prices in the early nineties, when Indian cotton probably reached its lowest ebb. But there are still evidences remaining of

the work of these pioneers, and the renewed efforts which have recently been made by the Government Agricultural Departments in almost every province of India have led to the production of a large number of improved varieties, and some of them in considerable commercial quantities.

From the point of view of cotton-growing, Madras is certainly the best part of India, the "Benighted Presidency" showing a long lead over the others in the matter both of quality and quantity of staple cotton. Tinnevelly, which is largely grown in Southern Madras, is quite a satisfactory cotton, a good deal of which found its way to Liverpool before the war; and the latest discovery known as "Cambodia" promised at first exceedingly well, being of very satisfactory staple, and otherwise a very good cotton. It is, unfortunately, showing signs of deterioration in quality, like so many others everywhere; but this is the universal tale of new cotton all over the world, for it is one thing to produce a new and improved variety of cotton, and another and much more difficult thing to keep it reasonably pure under field conditions. India, however, is probably rather worse than its rivals in this respect, for one reason. The ginning of the crop in most parts of the country (Madras, by the way, provides many exceptions) is in the hands of small native firms, or individuals who seem to be incorrigibly addicted to all the vices of the handlers of cotton throughout the world, especially the worst vice of all—that of mixing good cotton with bad in the hope of selling the whole at the price of the superior variety. More time and money have been lost in that way than by almost any other piece of dishonest dealing in the world; for the inevitable effect is to bring the whole crop in a very few years down to the level of its worst components. But in Madras, in 1916, an attempt was made to introduce a system of handling this abuse, which deserves to be advertised, whether it succeeds or not, as a model of what might be done by trade organisation on the right lines. A short-staple variety known as Pulichai had been introduced into the Tinnevelly district, which is entirely devoted to staple cotton, and at first it caught on very well, because it yielded quite as well as the longer stapled variety, and gave a slightly larger ginning out-turn, and as long as it could be passed off successfully by mixing with the superior variety of the district it paid the growers very well. But the cotton trade in Madras is largely in the hands of European firms of standing, who had sufficient foresight to see that such methods would very soon defeat their own ends, and incidentally destroy the whole superiority of the crop of the district. In consultation with the Director of Agriculture for the province, Mr. D. T. Chadwick, they entered into an agreement that, after having given the growers ample warning of their intention, they would after a certain date refuse to purchase at any price cotton which contained any admixture at all of the Pulichai, and fortunately it was easy to tell, owing to the different character of the seed, when such admixture had taken place. Some of the growers, with their usual disregard of such threats, calmly went on sowing mixed seed as before; but when the ginning season of 1916 came round they found to their surprise that the dealers meant what they had said, and would not buy the mixed crop. The crisis had not reached its final *dénouement* when the writer left the district; but it is very much to be hoped that the determined stand taken by the authorities of the trade was successful, not only as a warning to the growers of the district, but also as a precedent for other districts. It is very much to be regretted that conditions elsewhere do not permit of such methods being generally applied, because in most cases the ginners are small men and numerous, and it is impossible under present conditions to deal adequately with this problem of mixing. Until something is done, however, there will be no serious possibility of improving the Indian crop. Every attempt made by the Government Departments to introduce new and improved seeds is stultified by such practices, which pay nobody in the long-run.

This difficulty merges into another. It is exceedingly difficult to get the trade in most parts of India to recognise the value of good staple cotton, and to encourage its growth by offering a good price for it, especially in the early stages. This is, of course, not confined to India—the same difficulty is met everywhere; but in India there is a serious lack of any public-spirited body which is prepared to shoulder the burden of helping a new cotton through its early years, when, owing to the small quantity available, it is not worth while for any merchant as a business proposition to pay its real value for the small quantities which are all that is obtainable. But this attitude seems to have developed in certain parts of India into a confirmed habit of mind which refuses to

recognise the value of staple at all. It is very striking how all over India one finds the tendency to value cotton, not by the length of its staple, but by its ginning outturn. Thus in two districts of Bombay, the writer found superintendents of experimental farms deliberately selecting cotton for their ginning outturn alone, regardless altogether of staple as a factor in their value; and this is attributed to the general attitude of the trade in India. The excuse of the officials is always the same, "The trade won't pay for staple," and it is perfectly true. There are honourable exceptions, of course; but the greatest difficulty that the breeder of new cottons has to meet is the apparent impossibility of getting anything like a fair premium for improved staple cotton, with the result that the growers will not take up the improved varieties. It is only fair to add that there is one notable case in which this attitude of the growers is probably justified. In the Central Provinces there has been developed in recent years a remarkable variety of short-stapled cotton called *Roseum*, which possesses probably the highest ginning outturn of almost any cotton in the world, running sometimes over 40 per cent. (against a maximum of about 33 per cent. in almost every other country). At the same time it gives such a heavy yield per acre, compared with other longer stapled varieties of the same district, that there is simply no question between the two, especially as the staple of the *Roseum* is not so very short after all, being well over ½ in., while the usual native varieties such as Bengal are generally below that. But the writer's feeling in going through different provinces in India was that in other districts the example of the Central Provinces is too often followed where the conditions are by no means so conclusively in favour of that course. There can, of course, be no question that the duty of the Agricultural Department is to give the cultivator the cotton which will pay him best, in view of all the factors which go to make up the value of the crop, including yield per acre, ginning outturn, staple and price; but the tendency in many cases seemed to be to go for ginning outturn alone, because the growers and the trade would not pay attention to anything else, although the agriculturist knew that there was another variety which *ought* to pay the cultivator better if the trade would only give the grower its fair value. Thus staple has been neglected for ginning outturn, and as the two are practically opposing factors, the weight of the Government influence has in effect been thrown into the scale of short staple because it was the line of least resistance. The disadvantages of this policy, or rather of this acceptance as inevitable of admittedly undesirable conditions, are shown by the experience of two different provinces. In Bombay there seems reason to believe that, both in the Dharwar country and in Broach and Surat, there is a distinct tendency towards the loss of staple, while in the Punjab the very same Dharwar cotton has been distinctly improved, and a market has been made for it by the adoption of methods which have compelled the trade to recognise its superior value. This has been done by the system of Government auctions for the improved cotton, and when the local trade attempted to boycott these sales the representatives of large outside firms were brought up to the Punjab from Bombay and Nagpur, and made even higher prices. The result was that last year the premium for American cotton over the ordinary *desi* variety was over 50 per cent.

One cannot help feeling that the prospects of improvement in India are better just in proportion as that spirit has been developed. The apathy of the trade is, perhaps, the greatest difficulty of the whole matter; but it cannot be allowed to spoil the prospects of improvement, especially in a new district like the Punjab, where the possibilities of improvement are so great; for the Punjab is in a way the most promising district in all India at the present moment. The improvement of the irrigation facilities due to the completion of the great Triple Canal System, which has already been described in this Society's records, is one of the greatest achievements in the direction of cotton-growing under irrigation in the world, and its effects upon the Punjab crop are bound to become increasingly apparent. The great *doabs* lying between each pair of the Five Rivers are now being converted into fertile areas, much of them suitable for cotton-growing, where there was nothing before but glaring desert and the scantiest monsoon cultivation in patches. That the Punjab can grow large quantities of good cotton is now beyond question; but the trade cannot be left to itself to handle the crop in its own haphazard way.

It is unfortunate that the rapid development of irrigation facilities in the Punjab has inevitably been, to some extent, at the expense of similar schemes lower down the Indus in Sind. This is a subject which has also been fully dis-

cussed before this Society, and the writer need say no more than that the prospects of large development of cotton-growing of the best kind in Sind are assured as soon as the water supply can be given by the completion of irrigation works. It does seem tantalising that, with the world crying out for more cotton and willing, as it is now, to pay a high price for it, an enormous area such as Sind should be lying desert, where, with the expenditure of a few millions, a magnificent crop of cotton could be grown which would probably pay for the cost of the necessary works in a few years. Sind has well been described as a second Egypt, and it is a pity that its development could not be pushed on as rapidly as has that of Egypt during the last twenty years. But India suffers from the fact that it is so huge a country, and that it has been in the past a very poor country, and outside capital for its development has not been available in sufficient quantity, so far at least as cotton is concerned.

That, indeed, brings us to the crucial point of the whole cotton problem in India. The position is changing rapidly, and the methods to be adopted will require to be changed too. Until comparatively recently it was not at all sure whether, taking both political and economic considerations into account and under the conditions generally existing, cotton really did pay any better than plenty of other crops. But the recent rise in the price of cotton must have completely changed the position, and there can hardly be any doubt that at anything like present prices cotton, especially good cotton, would pay India better than any other competing crop. The problem is therefore, first, whether such prices are likely to last; second, how the improvement of the quality and the increase of the yield of the Indian crop are to be secured; and, third, how the full value of the crop is to be secured to the cultivator in face of the inertia and apathy of the trade towards improvements.

As to the first question, the writer has already stated his belief, and the reason for it, that we are in for a long spell of high cotton prices. The real basis price of cotton is the price in New Orleans, and that will not fall much or for long below 12 cents per lb. The second problem is one for the Government to consider. It is useless to expect the conditions in India to change of themselves. The Government must do something, and two possible lines of action may be suggested. In the first place, however, it is necessary to guard against giving the impression that the Government have done nothing, or are not willing to do anything that lies within their power. On the contrary, they have spent money freely on the development of agricultural colleges and on experimental and demonstration work of various kinds in agriculture; but they have not yet found courage to go to the root of the matter, which lies in the fact that the trade will do nothing towards the necessary reforms on its own initiative, and that the growers, including the Government Departments of Agriculture, *can* do nothing against the inertia of the trade in a country like India. The obvious conclusion, therefore, is that the Government must do something more than they have hitherto attempted, and that either by exercising compulsion towards reform or by setting an example themselves on a large commercial scale. On these lines the writer desires to put forward two definite and practicable proposals for immediate reform which the Government might reasonably be asked to take up at once.

The first is that the Government should introduce a system of licensing and control of the ginneries, which would give them power to put a stop to such practices as damping and mixing cotton and allowing dirt to find its way into the bales, even if there be no truth in the tales of still more extreme practices in that direction. The method of handling the loose bale from the ginning room to the press, which the writer himself saw in a ginnery in Dharwar, was enough. The newly ginned cotton, in a loosely made cover of sacking, with its contents projecting at every corner, was deliberately rolled over and over in the dust of the ginnery yard, which, of course, was inches deep, from the gin room to the press, a distance of apparently at least a hundred yards, and by the time it reached its destination it was hardly possible to distinguish between the colour of the cotton and that of the jute bagging in which it was wrapped. Again the answer to all protests is the same —"The trade does not object, and will not pay for clean cotton." To introduce compulsory control of this kind would, perhaps, be a new departure in India, but it is no new departure in the cotton world. It has been done in Egypt with satisfactory results. It has been done in the Sudan with the result of adding pence per pound to the value of the Sudan cotton. Surely it is no stretching of the limits of good government to compel abstention from practices which are dishonest as well as short-sighted.

Second, the Government must, either of itself

or through some suitable agency, show, on a considerable commercial scale, how a cotton plantation could and should be worked, and the opportunity has arisen under ideal conditions to make such an experiment. Two years ago the Government of the Punjab, on the occasion of the third visit of the indefatigable secretary of the International Cotton Federation to India, were persuaded to offer to the Federation a piece of land extending to 7,500 acres in the Lower Bari Doab Canal Colony for the purposes of a seed farm and model cotton plantation on terms which would have enabled a really satisfactory experiment to be made. Unfortunately, owing to the war it was impossible for the Federation, which includes Germans and Austrians in its membership, to take up the offer; but the Punjab Government next offered the concession to the British Cotton Growing Association, which still has it under consideration. If they unfortunately cannot see their way to take it up and find the necessary capital, which need not be very large, for carrying out the scheme, it is most earnestly to be hoped that the Government of India will see the advisability of doing it themselves. What is wanted is to test the question of cotton-growing in India in every respect, by growing the best cotton that can be grown under irrigation conditions in the Punjab, picking, ginning, baling, and generally handling it in the best possible way, and putting it on the best possible market wherever that may be. There are many in India who maintain that Indian cotton should be retained for manufacture in India alone—just as there are some in Lancashire who refuse to take any interest in cotton-growing in India unless the cotton is to come to Lancashire. With such narrow views on either side the writer has no sympathy whatever. Let both markets be tested, and let the best price win. If it be true, as it may well be, that India, owing to the handicap of the high freight, can afford to pay a higher price on the spot for good staple cotton than Liverpool, then by all means let India keep the cotton, if she can employ it to the best advantage, and there are indications that India is developing rapidly in the direction of finer spinning. The best of the large firms in Bombay have realised that the competition of Japan in the coarser counts is telling very severely on the Indian trade, which was chiefly in that branch, and that if the Indian industry is to be saved, let alone developed, it will be by following the example of England, and gradually working up to a superior class of product. Japan herself is showing the wisdom of that course, and is steadily working up towards fabrics a good deal above the grade of the cheapest of the cheap with which she has recently been flooding the Indian market, and even to some extent our own in this country. The development of the Japanese industry since the war would make a study in itself; but here we must confine ourselves to the actual and probable effects of it upon the Indian industry, both as regards cotton-growing and cotton manufacturing. Japan has certainly been the best outside customer for Indian cotton, especially the staple varieties, since the war. She has bought Punjab-American and Madras cottons very freely, following her usual policy of buying in India when American prices are dear, and especially now with the additional handicap of high freights on the more distant crop. It is quite likely, therefore, that Japan will prove to be a very keen competitor for any increased supply that may become available of staple varieties of Indian cotton. But the writer's contention is that there should be no discrimination in favour of or against one purchaser or another. The object of the scheme is, in the interests of India, to find the best market available for improved Indian cotton, and no other consideration should be allowed to come in the way of that object. He still believes that in the long-run the cotton will come to Liverpool, because Lancashire is always the best market for cotton, especially good cotton. But even from the selfish point of view, if it should prove otherwise, it would still be to the gain of Lancashire to see such a new source of supply of cotton developed though she never handled a bale of the product. It cannot be too often repeated that the basis of the whole situation to-day is a world shortage of cotton, and every bale of cotton produced anywhere is so much to the good, whether it be consumed in the country where it is grown or exported somewhere else. The only condition which sound economics dictates is that the cotton must be used to the best advantage.

In passing, it may be noted as an interesting feature of the war situation that a considerable quantity of Uganda cotton has been imported into India recently, and that the better class of Indian mills in the Bombay and Ahmedabad districts competed keenly for the supply. Here, again, the handicap of freight has, of course, told heavily in favour of the Indian purchaser, especially because there is frequently a consider-

able volume of shipping running light from East African ports to India, which is glad to pick up an odd lot of cargo like cotton, and there is some possibility that this trade may develop. But it is also to be taken as another straw showing which way the wind blows in the Indian cotton-manufacturing industry.

The many-sided character of the question of the best market for Indian cotton which has thus been raised is another argument for the experiment which the writer is advocating; but, whatever may be the result on that point, the success of the Punjab scheme is assured, and it would very quickly be made a precedent for other provinces to follow. For it seems beyond doubt that practically nothing can be done to meet the present situation in India adequately except by vigorous Government action of some sort. For years the Government have exhorted the cultivator to improve his methods, and have demonstrated and offered to assist in the adoption of better ways, but with comparatively little effect. It is beside the question to discuss where the responsibility for this comparative failure lies, or how it should be distributed. It is idle to blame it entirely on the growers or entirely on the trade, and certainly the time was not ripe till now for the Government to step in and take action which could only be justified by the proved failure of private enterprise to achieve reform itself. But that failure is now definitely proved, and the question is simply whether the Government will take action, or allow the whole thing to go by default. For the fact must be faced that, if reform is to proceed at the present snail's pace, it will be generations before any substantial improvements can be effected, and by that time it may be too late for India to reap the benefit which is now offered to her. It must be remembered that India has a very serious prospective rival in the enormous undeveloped areas of Africa. Nigeria, once it is fully developed, will run India very close as the ideal cotton country—in fact, except in the matter of population, India has probably very little advantage, except time, on her side. What the world wants is an *immediate* increase of the cotton supplies. India alone can possibly meet that need. If she does not take her chance now she may be too late later on.

It would be foolish, however, to pretend that the proposals which are here put forward are free from considerable difficulties. The first and worst of these is probably that of finding the necessary staff. For years it has been dinned into the ears of the Indian Government that the staff of the Departments of Agriculture was ludicrously inadequate. The writer came across an instance of this in one province, where a young Deputy Director of Agriculture had a district of 25,000 square miles (more than twice the whole cultivable area of Egypt) to look after, in which he was responsible for the supervision of all the crops, not merely cotton. It will take him probably all the years he will spend there to get through the whole of his district once. But the Government are now fully alive to this necessity, and are doing what they can to meet it. Unfortunately, their change of policy came just too late, for the war has taken away some of the existing staff and all of the type of young student at home who might have been tempted into such appointments, and now the supply is practically dried up for some time to come. The same difficulty would apply to the question of the proposed control of the ginneries. There is no staff available for the work, except perhaps in one Department—that which administers the Cotton Excise Duties. To those who know anything of the attitude of India on this question, it need hardly be explained that they would very willingly dispense with the services of that Department; and its abolition might even reconcile them to what they would otherwise regard as an intolerable interference with the liberty of the subject in the control of the ginneries.

To sum up, India is the only country in the world from which there is any hope of obtaining an early if not immediate increase of a million bales per annum of new cotton, and there is every reason to believe that India could maintain such an increase cumulatively till her present crop was at least doubled. As will be seen from Table D in the Appendix, the area under cotton is immense—over 25,000,000 acres in 1913-14, or two-thirds of the whole area under cotton in America, though it may be noted in passing that, as will be seen from Table E, the increase of the Indian crop has hardly kept pace with that of the American over the last thirty years. Quite apart from any extension of this area, the crop could easily be increased by a gradual improvement of the yield per acre, which is the lowest in the world, only about 85 lb. per acre against nearly 200 lb. in America, and about 400 lb. in Egypt. That such an increase would pay India handsomely at anything like present prices of cotton is beyond question, and it could be done without interfering at all seriously with India's essential

supplies of other crops, especially food supplies. To effect such a change in the Indian crop is a very big problem full of practical difficulties, which, however, are not utterly insurmountable. It will take a good deal of time and money to make the change, but it would take more money to get the same results in any other part of the world, and it probably could not be done at all in the time anywhere else. It is not, however, merely a question of growing an extra crop in certain parts of India, but of steadily and continuously improving the Indian crop a little all round, both in quantity and quality, by the adoption of better methods and the use of improved seed. That means constant and sustained effort on the part of every one concerned in agriculture in India and a very much increased staff, backed by determined action on the part of the Indian Government in the direction of compelling reform of dishonest methods, and showing an example itself on a commercial scale of how things could be and ought to be done. It will take something little less than a revolution to convert the Government of India to such a change of their long-established policy; but steady pressure must be exercised in that direction in Lancashire, in Parliament, at the India Office, and wherever the interests of our Empire and our great cotton industry are considered.

In thus pressing the interests of India on public attention, one must not forget that equal importance attaches to the development on similar lines of all our other Colonies. India comes first, in the writer's opinion, because cotton is already an established and developed industry there, which only needs encouragement and redirection to produce immediate results. But the development of Africa, which means the development of railway, river, and road communications throughout the whole of that enormous continent, must keep pace with that of India. It is largely a question of expenditure. Literally hundreds of millions could be spent on the development of Africa, and profitably. For it is one of the consolations of this very arduous task that everything that is done to encourage the development of new cotton fields is leading directly and equally to the development of every other crop that these new countries can produce, and to their advancement in every respect that means civilisation. The writer was much struck by the remark of an official in a most successful cotton district in India—that wherever cotton appears wages and the standard of living of the cultivators immediately begin to rise, the only drawback of that rise being that the cheap labour which is so much in favour of Indian and African cotton-growing promptly becomes comparatively scarce and dear. But there is so great a margin between the rate of wages current to-day in the Southern States of America and those in India and Africa, that it will be a very long time before the rise in the latter countries can make cotton-growing as difficult as it now is in America. One can hardly imagine the rate of wages in India rising to the dollar or dollar and a half per day which is now the current level in Texas. The pity of it is that this enormous rise of wages in America has not led to anything like a corresponding improvement in the status of the American negro as a man. His expenditure has increased in proportion, but is in many directions foolish in the extreme and of a kind likely to do him and his family the least possible good. It is of the first importance that such a state of affairs should not be allowed to reproduce itself in India or Africa, and, unkind as it may seem, it is probably true that the only way to prevent it is to hope that the rise in wages there may be gradual, so that the cultivators may learn to use their increased earnings wisely as they go along. For it must be emphasised at every turn that our chief anxiety in this proposed development of cotton-growing in India and our other Colonies must be to see that the interests of the cultivators are adequately protected in every way—that they are indeed made our very first care. We must guard against the accusation that we are only seeking to develop cotton-growing in these countries in order to secure the necessary supplies of raw material for our own industries. That it will have that result is, in this view, only incidental. The writer would be no party to any campaign for the development of cotton-growing throughout our Empire if he were not thoroughly convinced that in this matter the best interests of the old country and the new are identical, and that our need is their opportunity.

Finally, he would once more emphasise the great need for immediate action. The present situation is critical in the extreme. It is probable that it will appear less critical before long, because large crops throughout the world next year will ease the present scarcity and lead to a fall in prices again, though only to a level which will still be comparatively high. But we must not be lulled into a false sense of security by such a fall. As long as the world remains so largely dependent on the American cotton crop we shall at any moment be open to a repetition

of the disastrous conditions of this season; and that is a state of affairs which can no longer be tolerated. This time the question must be fought to a finish. The remedy lies in our own hands. It will cost time and money—much money, perhaps as much as we are spending on this war in the course of a few days; but it will be a better investment than that, and it will pay all the better the sooner it is made. Every pound spent now will be worth a hundred a few years hence. The question is one which will not wait till "after the war."

APPENDIX.

TABLE A.—THE WORLD'S COTTON CROPS, 1902-1916.

IN BALES OF APPROXIMATELY 500 LB.

Season.	America.	India.*	Egypt.	Russia.	China.	Others.	Total.
1902-1903 . .	10,758	3,367	1,168	342	1,200	801	17,636
1903-1904 . .	10,124	3,161	1,302	477	1,200	751	17,015
1904-1905 . .	13,557	3,791	1,263	536	756	803	20,706
1905-1906 . .	11,320	3,416	1,192	604	788	936	18,256
1906-1907 . .	13,551	4,934	1,390	759	806	1,027	22,467
1907-1908 . .	11,582	3,122	1,447	664	875	950	18,640
1908-1909 . .	13,829	3,692	1,150	698	*1,250*	969	*21,588*
1909-1910 . .	10,651	4,718	1,000	686	*1,750*	950	*19,755*
1910-1911 . .	12,132	3,853	1,515	895	*1,800*	967	*21,162*
1911-1912 . .	16,043	3,288	1,485	875	*1,800*	1,058	*24,549*
1912-1913 . .	14,129	4,395	1,507	911	*1,800*	1,171	*23,913*
1913-1914 . .	14,610	5,201	1,537	1,015	*2,000*	1,340	*25,703*
1914-1915 . .	15,067	5,209	1,298	1,247	*2,000*	*1,300*	*26,121*
1915-1916 . .	12,953	3,819	961	1,465	*1,750*	*1,100*	*22,048*
1916-1917 . .	*12,500*	*4,500*	*1,200*	*1,400*	*2,000*	*1,200*	*22,800*

For sources and details see "The World's Cotton Crops," Statistical Appendix A.

The very high figures officially quoted for the Chinese crop a few years ago are now generally discredited. No reliable information whatever is available. The figures in *italics* are the author's estimates only, very little statistical information or none at all being available.

* These are the Government estimates, which are notoriously understated. On the other hand, Indian bales are only 400 lb. weight. Taking the Government figures as 500-lb. bales, as is done here, probably offsets the under-estimation fairly well on the whole, though roughly. The following table from the *Economist* of September 23rd, 1916, seems to justify this approximation.

Season.	Government Estimate.	Approximate.	Actual Crop.
	400-lb. Bales.	400-lb. Bales.	500-lb. Bales.
1908-1909	3,691	4,744	3,795
1909-1910	4,718	5,341	4,273
1910-1911	3,853	4,974	3,979
1911-1912	3,288	4,643	3,714
1912-1913	4,610	5,019	4,015
1913-1914	5,065	6,684	5,347
1914-1915	5,209	5,279	4,223
1915-1916	3,819	5,559	4,447
Average	4,282		4,224

Based on Exports, Indian Mill Statistics, and estimated domestic consumption.

TABLE B.—BALANCE OF PRODUCTION AND CONSUMPTION OF COTTON.

	World's Commercial Crops and Mill Consumption.*				†American Crop and World's Consumption thereof.			
	Mean Crops.	Mean Consumption.	Balance.	Average Price of American, Indian, and Egyptian.	Commercial Crops.	Consumption.	Balance.	Average Price of American.
1904-1905 .	19,648	17,726	+ 1,922	5·66	13,656‡	12,664‡	+ 992‡	4·93
1905-1906 .	17,266	18,214	− 948	6·73	11,443	12,081§	− 638	5·94
1906-1907 .	20,815	19,523	+ 1,292	7·21	13,735	13,203§	+ 532	6·38
1907-1908 .	17,564	19,393	− 1,829	6·68	11,456	12,112	− 656	6·19
1908-1909 .	20,229	19,828	+ 401	6·29	13,831	13,157	+ 674	5·50
1909-1910 .	17,216	19,148	− 1,932	9·10	10,592	11,754	− 1,162	7·86
1910-1911 .	18,854	20,222	− 1,368	8·54	11,986	12,054	− 68	7·84
1911-1912 .	22,157	21,495	+ 662	7·09	16,108	14,515	+ 1,593	6·09
1912-1913 .	21,503	22,302	− 799	7·57	14,106	14,715	− 609	6·76
1913-1914 .	23,309	22,296	+ 1,013	7·52	14,882	14,541	+ 341	7·26
1914-1915 .	Complete statistics not available.				15,108	13,834	+ 1,274	5·22
1915-1916 .					12,938	14,812	− 1,874	7·51
1916-1917 .					*13,000*	*14,000*	*− 1,000*	—

* For sources and details and a diagram based on the world's figures see "The World's Cotton Crops," Statistical Appendix B.

† Figures of crop and consumption compiled by H. G. Hester, Secretary of the New Orleans Cotton Exchange.

‡ From Shepperson's Cotton Facts. § Takings, not consumption.

TABLE C.—AMERICAN COTTON CROP STATISTICS, 1889-1916. ||

Season.	Acreage Census. (Bureau Figures.)	Crop. (*Chronicle's* Figures.)	Yield per Acre.	Average Price of Middling.
				Pence per lb.
1889-1890	20,175,270	7,313,726	0·36	6·19
1890-1891	20,509,853	8,655,518	0·42	5·00
1881-1892	20,714,937	9,038,707	0·44	4·12
1892-1893	18,067,924	6,717,142	0·37	4·61
1893-1894	19,525,000	7,527,211	0·39	4·19
1894-1895	23,687,950	9,892,766	0·42	3·44
1895-1896	20,184,808	7,162,473	0·35	4·38
1896-1897	23,273,209	8,714,011	0·37	4·22
1897-1898	24,319,584	11,180,960	0·46	3·47
1898-1899	24,967,295	11,235,383	0·45	3·28
1899-1900	24,275,101	9,439,559	0 39	4·87
1900-1901	25,758,139	10,425,141	0·41	5·16
1901-1902	27,220,414	10,701,453	0·39	4·78
1902-1903	27,114,103	10,758,326	0·40	5·46
1903-1904	28,016,893	10,123,686	0·36	6·94
1904-1905	30,053,739	13,556,841	0·45	4·91

|| From "The World's Cotton Crops," p. 100, where a diagram will also be found.

TABLE C.—AMERICAN COTTON CROP STATISTICS, 1889-1916 (*continued*).

Season.	Acreage Census. (Bureau Figures.)	Crop. (*Chronicle's* Figures.)	Yield per Acre.	Average Price of Middling.
				Pence per lb.
1905-1906	26,117,153	11,319,860	0·43	5·95
1906-1907	31,374,000	13,550,760	0·43	6·38
1907-1908	31,311,000	11,581,829	0·37	6·19
1908-1909	32,444,000	13,828,846	0·43	5.50
1909-1910	32,044,000	10,650,961	0·33	7·86
1910-1911	32,403,000	12,132,332	0·37	7·84
1911-1912	36,045,000	16,043,316	0·45	6·09
1912-1913	34,283,000	14,128,902	0·41	6·76
1913-1914	37,458,000	14,609,968	0·39	7·26
1914-1915	37,406,000	15,067,000	0·39	5·22
1915-1916	32,107,000	12,953,000	0·40	7·51
1916-1917	35,239,000	*12,500,000*	*0·36*	—

TABLE D.—INDIAN COTTON. GOVERNMENT ESTIMATES OF AREA AND CROP, 1911-16.
(Area in acres. Yield in bales of 400 lb. 000's omitted throughout.)

Provinces and States.	1911-12.		1912-1913.		1913-1914.		1914-1915.		1915-1916.	
	Area.	Yield.	Area.	Yield.	Area.	Yield.	Area.	Yield.	Area.	Yield.
Bombay	*5,121*	*599*	*6,064*	*1,324*	*6,574*	*1,439*	*6,953*	*1,544*	*4,249*	*893*
Baroda.	*665*	*96*	*762*	*196*	*749*	*175*	*843*	*229*	*566*	*117*
Sind	*346*	*124*	*296*	*123*	*341*	*135*	*336*	*116*	*169*	*51*
	6,132	819	7,122	1,643	7,664	1,749	8,132	1,889	4,984	1,061
Central Provinces and Berar	4,648	913	4,493	910	4,754	961	4,708	1,097	4,061	1,106
Hyderabad.	3,234	300	2,888	300	3,653	400	3,605	400	3,220	450
Madras	*2,878*	*335*	*2,414*	*471*	*2,725*	*308*	*2,115*	*245*	*2,188*	*357*
Mysore	*101*	*17*	*154*	*19*	*90*	*10*	*109*	*14*	*92*	*14*
	2,979	352	2,568	490	2,815	318	2,224	259	2,280	371
Punjab	1,582	241	1,575	373	2,053	612	1,857	486	918	196
Central India	1,400	228	1,314	206	1,426	273	1,519	293	999	216
United Provinces	921	251	1,158	428	1,586	484	1,551	486	834	262
Rajputana	263	73	393	125	470	132	421	166	244	66
Burma	186	32	233	46	290	54	270	42	190	27
Behar and Orissa	88	19	92	19	73	17	70	16	68	16
Bengal	63	25	51	21	87	24	90	34	88	30
N.-W. Frontier	56	12	56	13	59	14	60	14	26	6
Assam	36	11	35	10	33	12	34	12	32	10
Ajmere-Merwara	27	12	50	26	57	15	54	15	23	2
	21,615	3,288	22,028	4,610	25,020	5,065	24,595	5,209	17,967	3,819

(For Commercial estimates of approximate actual crop, see Table A.)

TABLE E.—COMPARATIVE INCREASE OF THE AMERICAN AND INDIAN CROPS.*
(Running Bales, 000's omitted.)

Season.	American.	Indian.	Per cent.	Season.	American.	Indian.	Per cent.
1888–1889 . .	6,935	2,922	42	1903–1904 . .	10,124	4,141	41
1889–1890 . .	7,314	3,348	45	1904–1905 . .	13,557	4,061	30
1890–1891 . .	8,655	3,020	35	1905–1906 . .	11,320	4,797	42
1891–1892 . .	9,039	2,959	33	1906–1907 . .	13,551	5,195	38
1892–1893 . .	6,717	2,891	43	1907–1908 . .	11,582	4,303	37
	Average of 5	*years .*	*40*		*Average of 5*	*years .*	*38*
1893–1894 . .	7,527	2,911	39	1908–1909 . .	13,829	4,779	35
1894–1895 . .	9,893	2,688	27	1909–1910 . .	10,651	5,317	50
1895–1896 . .	7,162	3,296	46	1910–1911 . .	12,132	4,587	37
1896–1897 . .	8,714	2,999	34	1911–1912 . .	16,043	4,178	26
1897–1898 . .	11,181	3,100	28	1912–1913 . .	14,129	4,385	31
	Average of 5	*years .*	*35*		*Average of 5*	*years .*	*35*
1898–1899 . .	11,235	3,477	31	1913–1914 . .	14,610	5,201	36
1899–1900 . .	9,440	2,613	28	1914–1915 . .	15,067	5,209	35
1900–1901 . .	10,425	3,300	31	1915–1916 . .	12,953	3,819	30
1901–1902 . .	10,701	3,796	35	1916–1917 . .	*13,000*	*4,500*	35
1902–1903 . .	10,758	3,855	36		*Average of 4*	*years .*	*34*
	Average of 5	*years .*	*32*				

* From Turner, Routledge & Co.'s Cotton Diagram.

DISCUSSION.

SIR GEORGE TOULMIN, M.P., said he had endeavoured in a small way to impress upon the Colonial Secretary and the Secretary for India the very great importance of this subject as one of those things which should not be allowed to drop even during the war, but very little success attended the efforts which were made by two or three members of the House of Commons. He was rather more interested in the Colonies, perhaps, although he agreed with Professor Todd that if we were to get one million bales additional supply we were more likely to get it from India than from the Colonies. He was quite sure that a generous policy in this matter would pay. It was not possible to leave it in the hands of private enterprise; and although, perhaps, it was a curious policy to be advocated by a Radical, nevertheless he thought a policy of benevolent despotism was necessary in India. Looking at the matter from the Lancashire point of view, whilst they must in that district look at it from their own ideas, he believed there was sufficient public spirit there not to confine that interest in any one of the great outlying portions of the Empire just for their own selfish ends. He rather held that wherever suitable cotton was grown the reaction of the growth of that cotton must be to secure plenty for Lancashire. The licensing of ginneries, as suggested by Professor Todd, was a very practical suggestion, and a fit one for the Government. Similarly, what were certainly fraudulent practices, such as mixing, damping, and the admission of dirt into the cotton, were also matters coming within the duties of the Government. Again, nothing could be more valuable than the combination of the seed farm with the cotton plantation. As to whether India or the Home Treasury should be responsible or not for the finances of any such scheme, the Indian Government should not be slack in supporting even more fully than they had done any such proposals as had been made by the author, seeing that India would benefit very largely by the results. The great object was to secure a grade of cotton which was suitable for Lancashire and which could be relied upon. If that were done it would very soon become a commercial success.

Sir Louis W. Dane, G.C.I.E., C.S.I. (Ex-Lieutenant-Governor of the Punjab), said there was a great field for increased cotton cultivation in India, more especially in the provinces in which he served for thirty-seven years. Within the last twenty years the area irrigated by the Government canals had been increased by eight million acres, the bulk of this area being previously uncultivable desert with a rainfall of less than sixteen inches a year. This soil only needed water to make it first-class for cotton-growing. To his personal knowledge since the early eighties, all the district officers of India had been trying to do their best to secure cotton suitable for the Lancashire requirements. At first they were told that their salvation lay in growing Egyptian cotton, but it was found that the climate of the Punjab, strange to say, was too cold for this. During 1885 and 1886 a khaki cotton was grown which relieved them of the necessity of having to dye it, but this, although very excellent as regards colour, was shockingly poor in quality and quantity of outturn, and it had to be abandoned. In later years attention had been given to the American cotton which was found to grow properly, and, as Professor Todd had mentioned, the Dharwar-American type of cotton was now doing fairly well. The difficulty of it, however, was that it hybridised, and all sorts of proposals had been made to prevent this in actual cultivation. One of the suggestions of the Punjab Government was that, in connection with the Triple Canal scheme in the Montgomery district, a certain area of Government land should be reserved specially for the cultivation of this new variety which, after years of experiment, the Agricultural Department had succeeded in making fairly suitable. It was proposed that on an area of something like 90,000 acres a certain proportion of this cotton should be grown, or that any cotton grown should be that selected by the Agricultural Department. He believed that the proposal was still being considered, but owing to the war it might not be possible to carry it out in its entirety as had been suggested by himself. He had also proposed, as was pointed out in the paper, that an area of 7,500 acres should be granted on special terms for cotton-growing, and he was sorry that circumstances had prevented the International Federation from taking it up. There was no doubt that the land was available and the water was available, and the country could very easily put the million bales suggested by the author on the market in a short time. The population in the area now being irrigated was under 200 to the square mile of cultivation, but, when properly irrigated, this area would be easily capable of holding a population of 700 to the square mile of cultivation. Consequently there was a wide margin for non-food crops such as cotton. Perhaps the author had not given so much attention as he might have done to the extraordinary variations in the climatic conditions in India which made cotton a risky crop. Want of rain even on irrigated land was often fatal, and early frosts ruined the outturn. Then, again, the boll worm caused considerable trouble, but the Government entomologists had discovered a fly which, fortunately, preyed upon the boll worm just as the boll worm preyed upon the cotton, and the difficulties originally encountered of hatching out these flies before the boll worm hatched out had now been overcome. Much had been said of the rudimentary agricultural methods of India, but there were reasons for this. For instance, in regard to water-lifting, many of the wells in India would not stand pumping, and although most of the forms of water-lifting adopted in Egypt had been tried, they were not very much more successful than the indigenous water-lifting methods of India. They generally required expensive machinery in the shape of bullocks, and they were too costly altogether. Even if motor pumps could be used, and he believed that this would be the best solution for wells in Upper India able to stand the pump, the cost of transporting the necessary fuel 1,100 or 1,200 miles made them prohibitive at present. As to damping cotton, he had been asked to introduce a Bill into the Punjab Legislative Council to render it penal to do this. On going into the matter, however, he found the rather curious thing that the Punjab climate was extraordinarily dry, and the growers could not get enough cotton into the bale to draw the full weight, and a bale of cotton was paid for on the number of pounds it contained. When they reached the coast these short-weight bales absorbed quantities of moisture from the sea air, and the buyers were then able to sell bales of greater weight than those they purchased. Consequently, the growers thought they might as well put some water on the bales themselves before they sold them in the first instance. That was one reason why cotton was damped. He agreed that the ginning arrangements in many provinces were exceedingly defective, and probably no great improvement would be manifested without that benevolent despotism which Sir George Toulmin had referred to, and nobody would object to that at all seriously. At the same time he did not wish it to go forth that the Government of India had neglected this question. It was doing the best it could, and in the new irrigated portions of the Punjab there was still an immense field for cotton-growing. He assured them that the Punjab Government, under his very eminent successor, Sir Michael O'Dwyer, was doing all it possibly could to improve and extend the facilities for cotton cultivation there.

Mr. D. T. Chadwick, I.C.S., referring to the additional one million bales mentioned in the paper, pointed out that the author had first said there must be one million bales of high quality, but later he rather inferred that he wanted a million bales of any sort. The author had also laid to the charge of the ginneries the chief blame for all mixing. In that Professor Todd was largely correct, but the questions of mixing and marketing were not so simple as it might appear from the paper. It might seem heretical here in London to say that he was not at all certain that the trade of the world was agreed as to what "quality" in cotton meant. In Lancashire and London it meant long staple, but in India he knew European buyers who laid more stress on colour than on staple. That touched the question of marketing very closely, because it obviously made it much more difficult to check mixing if the large buyers were not agreed as to what exactly they wanted. Professor Todd had mentioned the difficulties experienced in marketing small quantities of better-staple cotton. With any new introductions or improved types the quantities coming on the market in the earliest years must necessarily be small. It was broadly true of all the provinces of India to say that in introducing such improvements it was only the mills in India which rendered assistance in the early years. To them and not to the export houses belonged the credit, if any, if these improvements became established on a commercial scale. Certainly Cambodia—or, as Liverpool called it, "Tinnevelly American"—would never have been heard of but for the interest displayed in it from the start by Messrs. A. & F. Harvey, Indian spinners. Many efforts had been made to deal with this difficulty of marketing. In Sind a buying agency was tried. In the Punjab the officers of the Agricultural Department collected the better cotton at different centres where they organised auctions for it. But in most cases resort was being had more and more to joint sales by villagers to particular buyers. Anyone who had had experience of organising co-operative sales of agricultural produce by farmers, would know how difficult it was to make that system a stable one, and to what insidious dangers it was exposed. That it possessed great possibilities might be illustrated from experience in Tinnevelly, which would also serve to illustrate the length to which officers of the Agricultural Department had been compelled to go to meet this difficulty of marketing for quality. The seed of an improved strain of better quality, and yielding 4 per cent. more lint than the local variety, was distributed. All the farmer got was the extra money for the little bit of extra quantity. He could get nothing for the better quality until the local mills agreed to pay a fixed premium of Rs. 3 on the produce of this seed brought to them direct by the growers. This meant they were paid at a rate of about Rs. 183, instead of about Rs. 180. Officers of the Agricultural Department went with the villagers to the mills and vouched for the cotton. The firm were so satisfied that next year they offered Rs. 5 premium. Next year the premium opened with five and closed with six—other mills were getting interested. The cultivation of this strain was extending, and in this year—1916—export houses began to display interest in it. The season opened with a premium of Rs. 10, and when he left India last June it had reached Rs. 16. It was obvious when such a system as this became widespread it made great demands on the staff to supervise it. He, personally, was afraid that this premium of Rs. 16 would tempt some to mix their seed, and the whole system might get beyond the strength of the present Agricultural and Co-operative Departments to cope with. The Agricultural Departments in India had been led on from experimental, selection and demonstrational work, to the business of seedsmen on a large scale, and finally to the organising of auctions and the fostering of co-operative sales of produce. To cope satisfactorily with such varied duties demanded a very large increase of staff. Professor Todd asked for another million bales, and in support of the possibility of it he laid stress on the actual price of cotton at the moment. He feared that statement was hardly a complete one. It was not so much the actual price of cotton which was of moment, but the ratio between the price of cotton and that of other market crops. The prices of other crops also were now up—sugar, for instance, and how about indigo where cotton came in conflict with that? He also thought that the cotton maps of India which were published gave a false idea of the possibilities of India as a cotton producing country. He had seen maps which showed cotton growing in the rice fields of Bengal; whereas the truth was that, on the whole, the cotton tracts were well defined and were almost all found in the western half of the country. Great progress had been made in increasing the yield of cotton per acre, especially in the Central Provinces, where a heavy yielding short staple variety had been found to give 110 per cent. more yield than that of a long staple kind which was first tried to be encouraged. The hope and ultimate aim would seem to be to establish definite types of cotton in definite areas of India; but to succeed in this they needed all the assistance and understanding possible from the trade. How potent such aid could be was suggested in Professor Todd's paper. If the agreement now come to in South Madras could hold for another year, more would probably have been achieved in two years for the purity and quality of Tinnevelly cotton than was likely to have been done in eight. Cotton also was not the only

crop in India. If anything, possibly a disproportionate amount of attention had been given to it. In five provinces of British India 98 per cent. of the total area under cotton in British India was to be found, yet in those provinces cotton only represented 9 per cent. of the total area annually cropped. There were also oilseeds and jute to demand attention. And above all there was rice, which it should be remembered was the staple food for the greater part of the human race. He believed that both the quality and quantity of cotton produced in India could be increased; but most of the labour fell on the Agricultural and Co-operative Departments, and to cope with cotton and all the other crops satisfactorily they need to be very greatly strengthened. He would ask those spinners who were interested in Indian cotton to come to India and see the conditions there, and give them the benefit of their advice.

Mr. N. N. Wadia said the previous speakers had based their views on the importance of speedily increasing the growth of Indian cotton. He, as a spinner and manufacturer in Bombay, could speak on this matter from an entirely different point of view; but at the outset agreed that it was possible, with Government help, materially to increase within a reasonable time the growth of long-staple cotton in India. One of the first things to bring about this result was a considerable increase in the staff of the Agricultural Department in India. The amount of money spent on the Agricultural Department was Rs. 370,000, or less than 5 per cent. of that spent in America. The Agricultural Department was mostly staffed by members of the Indian Civil Service and not by agriculturists who have devoted their lives to agriculture pure and simple. In his opinion, therefore, it was necessary that under the heads of the Indian Agricultural Department, who might be men from the Indian Civil Service, a special staff of trained agriculturists from America, especially those who had made a lifelong study of cotton-growing, should be provided in each Presidency. The next point he wished to make was the method to be pursued by this Department. The Agricultural Department always complained that they did not receive adequate encouragement from the Indian millowners, and they had experienced considerable difficulty in marketing the cotton grown under their supervision. Some of the other millowners arranged with the Bombay Presidency and the Agricultural Department to establish a buying agency in Sind. This syndicate of millowners were requested by the Bombay Agricultural Department to erect ginneries for ginning, pressing and marketing the American cotton grown under the supervision of that Department in Sind, and also keeping the seed separate, one at Mirkhaphus and the other at Shikarpur. One of the main conditions made at the time of this arrangement was that the Agricultural Department would grow about 200 to 250 bales at each of the above places in the year and bring their production at both these places within three years to about 2,000 bales a year, so as to make the ginneries pay their way. They would be surprised to hear that this condition was never carried out, that at Shikarpur in the last five years only 100 bales had been grown, and the ginning factory established there had never been worked, although that factory was erected at the request of the Agricultural Department at a place selected by that Department. At Mirkhaphus this year's crop, after five years, had only reached 250 bales. Under such circumstances they would see that no buying agency could pay its way. Professor Todd had laid great stress on the prevention of mixing of different varieties of cotton, and for that purpose licensing ginneries by legislation. He agreed that this prevention of mixing could only be effected if Government would legislate in the matter. He, for the last twenty years or more, as a weaver bought cotton in the Nizam States, and he could say from his experience that in that district the staple of the cotton due to mixing of seed had materially deteriorated during the last ten years, and the cotton he used to buy there having a staple of nearly an inch was now less than five-eighths of an inch, and it was getting worthless for purposes of weaving. In his opinion also, if damping by legislation was stopped, it would materially prevent the mixing of cotton by agriculturists. He repeated that if the Agricultural Department was staffed by a proper number of trained agriculturists, not only good staple could be grown, but the quantity could be materially increased, and he did not see why in the next ten years we could not look forward to having a million bales more of good staple cotton from India. In conclusion, Mr. Wadia drew attention to the fact that Japan was to-day importing cotton from Bombay at very little over the pre-war rate of freight. She was also importing cotton from America at practically pre-war rates of freight. British spinners were handicapped by the high rates of freight they had to pay for cotton imported by them either from America or India. With this advantage of freight, therefore, Japan was placing in the Indian markets woven goods in competition with Lancashire mills, and it was necessary for Lancashire mills to face this competition, which would grow more and more in the near future.

Mr. Augustus L. Beaufort mentioned a few statistics to support his view that he did not see any possibility of increasing the crop of India by one million bales per annum. During the last fifty years, starting with the five years ending 1867–68, India produced a little over tw

million bales. At the end of twenty-five years it had risen to $2\frac{3}{4}$ millions, and in the next series of five years it had risen to $3\frac{1}{4}$ millions. In the five years ending 1902-3 it was $3\frac{3}{4}$ millions; in the following five years $4\frac{1}{2}$ millions; and in the five years ending 1912-13 it was just under 5 millions. These were his own estimates, but the Government estimates were considerably less. In fact, his own figures were about 30 per cent. increase on the Government returns. In 1913-14 the crop was estimated by the Government at just over 5 million bales, including one million taken for local consumption, but he made it $6\frac{3}{4}$ millions. In the last two seasons the crop had been about $5\frac{1}{2}$ million bales, and he did not see, having regard to the slow and steady increase he had shown, that there was any possibility of getting another million bales annually. They had been told that in the Punjab the possibilities were very great, and that would be the only possibility of getting this large quantity if it were to be obtained. As to the quantity taken by Great Britain, at the beginning of the last half century we took $1\frac{1}{4}$ millions of the $1\frac{3}{4}$ million bales shipped. That total had dropped, until in the last five years of the half century we only took 98,000 bales out of 2,150,000 exported. Lancashire was always calling out for India to increase her cotton supply, but she steadily kept away from it. As a matter of fact, Indian cotton was going in increasing quantities to Japan. At the beginning of the half century the Far East took 74,000 bales, but at the end of it Japan took nearly two million bales, and in the last season 1,900,000. The Continent took 100,000 bales in the early sixties, and in the year 1913-14 nearly two million bales; whereas the exports to the United Kingdom were 166,000 bales. The total home consumption at the beginning of the half century was 665,000 bales, and of that about 600,000 bales were taken for local consumption other than by the mills. That figure was on the authority of Mr. Rivett-Carnac, who was Cotton Commissioner of the Central Provinces and Berar fifty years ago. In an examination of the area under cotton in the twenty-five years ending 1914-15, he found that the mean of the first five years was 15,541,000 acres, and in the last five 23,142,000 acres; the respective yields, according to Government, being 2,400,000 and 4,405,000 bales of 400 lb. That showed an *annual* increase of 300,000 acres and 80,000 bales. To meet the proposal of Professor Todd an annual increase of at least five million acres would be required, assuming an average yield of 80 lb. per acre. In the same quarter of a century the mean quinquennial area in the Punjab had risen from 795,000 to 1,690,000 acres, and the outturn improved from 168,000 to 404,000 bales, equal to 894,000 acres and 235,000 bales, the mean annual increases being 36,000 acres and 9,500 bales.

MR. SHAPURJEE SAKLATWALLA said he also would be somewhat detached from the views of the previous speakers, as well as perhaps from those of the reader of the paper. India, from the cotton point of view, had too long been looked upon as the kitchen garden of Lancashire, and he objected to such a narrow point of view. A similarly narrow point of view had been taken by the author and other speakers in regard to the possibility of an increase in the cultivation of cotton in India. One of the reasons for the success of America in cotton-growing was that the agriculturists there were very intelligent and highly educated, and the difficulty was that India should be always looked upon as a land of plentiful and cheap labour. The labour problem of India should not be looked upon in that spirit. Some day the Indian agriculturists would have to have the same educational facilities as the American, and then when the Indian agriculturists were better educated, and paid wages perhaps ten times those they now received, they would give more intelligent interest to the needs of the country and the Empire than was the case at present. An important factor in this connection was the fact that at present the Agricultural Department in India was so aloof from the daily life of the industry and did not reap the benefit from, on the one hand, nor did it give the benefit to, on the other, the industry which it was supposed to. He agreed with Mr. Wadia that it was necessary to place the Indian Agricultural Department in the hands of agricultural experts. When this was done, and efforts made to improve and make happier the lot of the Indian agriculturist, the results would be seen in the quality as well as in the quantity of the output. He further pointed out that Indian merchants and City men failed to recognise that agriculture and agriculturists needed to be organised and wisely directed. For any small factory there were technical supervisors and a board of merchant directors, but the immense mass of illiterate agriculturists were left to their fate without direction.

SIR CHARLES S. BAYLEY, G.C.I.E., K.C.S.I., briefly proposed a vote of thanks to the author for his paper.

MR. B. ABDY COLLINS, I.C.S., in seconding, mentioned that whereas the author had suggested an expenditure of about £10,000,000 per annum upon cotton-growing in India, the Government at present spent about £500,000 on agriculture altogether. If the paper and discussion led only to the doubling of that sum a very great service would have been done to India.

The vote of thanks having been carried, PROFESSOR TODD, owing to shortness of time, said he would send his reply in writing to the *Journal*

In reply to the discussion, PROFESSOR TODD writes:—In answer to Lord Emmott's point as to cotton taking its character from the soil and climate, there is, of course, a great deal in this, but I believe that in many cases the resources of Mendelian breeding have not yet been exhausted, and it ought to be possible to produce cottons suitable for each different set of conditions which will be at least much better in quality than the varieties commonly in use. But to do so attention must be paid to *all* the factors in the value of a cotton, and not so entirely to the question of ginning outturn, as seems to be the rule to-day in many parts of India. It seems paradoxical that India, which has the smallest yield of seed cotton per acre in the world, should pay so much attention to the question of the yield of lint per boll. In answer to Mr. Chadwick, what the world wants is, of course, a million bales of about an inch staple, but if it cannot get that immediately, to add ⅛ in. to the staple of a million bales of short staple cotton is the next best thing. An additional million bales of any kind of cotton is always of use somewhere, and helps to relieve the pressure everywhere. It is true that other qualities besides staple, *e.g.* colour, "twist," strength and the "character" of the cotton, are important factors in its value, but in the cotton trade, as a whole, and especially in Lancashire, length of staple is the prime factor, while regularity of staple probably comes next. Mixing of staples of different length can never be profitable. Yet I have been told in the Punjab that it is the trade in Bombay who want it mixed. You should have heard the derision with which that statement was greeted when I repeated it in Bombay. It is literally true in India that one half of the cotton world does not know how the other half live nor what they want. Sir Louis Dane's remark about damping shows the vicious circle with regard to such practices. Because one section of the trade is making a profit at the expense of another that other introduces a countervailing practice which is frankly fraudulent in the degree to which it is carried. Incidentally the same trouble exists in America with regard to Texas cotton, which is picked very dry, and afterwards gains weight when exported. There is nothing I personally regret more than the comparative failure of the Sind buying agencies, referred to by Mr. Wadia, which has been largely due to mutual misunderstanding, but I hope success will still be achieved in Sind. I hope that when Mr. Saklatwalla reads the paper he will find that he was quite in error as to my attitude with regard to the Indian cultivator. It is a mistake to suppose that the average negro cultivator in America is either very intelligent or highly educated. In neither of these respects are his attainments proportionate to his remuneration to-day.

DR. THOMAS SUMMERS, C.I.E., writes:—The greater part of Sind has been proved to be fit for growing cotton, and it is probable that a million bales would soon be produced from the two to three million acres which would be put under cotton when water is provided. Mr. G. S. Henderson, while Deputy Director of Agriculture in Sind, in comparing Sind with Egypt, wrote: "Both the Indus and the Nile deltas have been formed by the natural deposition of silt through countless centuries. They consequently have practically inexhaustible soil, if only a proper system of cultivation is provided." Mr. F. Fletcher, another well-known cotton expert, who was also in Sind for some years, stated: "If the whole of Sind were put under perennial irrigation, the potentialities of the province for cotton-growing could not be surpassed even by the United States, and the annual value of the agricultural products of the country would amount to not less than twenty crores" (£13,000,000). Mr. Fletcher's estimate was looked upon as too optimistic, but it is not impossible; and I am convinced that, in Sind, Government possess the best and most economical field for the extension of cotton-growing in India, if not in the British Empire. If only a beginning is made, before long the "Cinderella Province" will be transformed into the "Garden of India" as predicted by Sir Colin Scott Moncrieff. This can be done at comparatively small cost by diverting on to the thirsty land some of the water from the Indus, which now flows uselessly through the centre of the province into the sea. As the supply in the Indus is sufficient to irrigate more than twenty million acres, there is no question of deficiency of water, which sometimes hampers irrigation schemes in other parts of India. Sind's greatest scheme—the Rohri Canal, which can be begun as soon as the war is over—will be the greatest canal in India. It will open up a million acres of good cotton land in five years, and two million acres in ten years, and the value of one year's crops is estimated at more than the cost of the canal. This great canal has been strongly advocated during the last sixty years by Colonel Fife, who was the first to propose perennial canals for Sind, by Mr. R. B. Joyner, C.I.E., and by other Sind engineers; also by Lord Reay, while Governor of Bombay, and by several Commissioners in Sind, beginning with Sir Bartle Frere, and ending with Mr. A. D. Younghusband, C.S.I., and Mr. W. H. Lucas, C.S.I.

SHANGTUNG HOG-BRISTLE TRADE.

The following account of the bristle trade in Tsingtau, contained in a Japanese Government report, has been sent to his Government by the United States Consul at Tsingtau. Shantung Province, in which Tsingtau is situated, exports about 500,000 lb. of bristles annually. They are produced throughout the province, but especially well-known places of

origin are Weihsien, Taian, Laifu, Chinchou, Shaho, Pingtu, Tsinau, Chinchiakou, and Sochen. Although a few white hogs are found near Kiaochow and Tsimo, in this province, almost all of the remainder are black. The only bristles exported are the long stiff ones found on the back and sides of the hog, while the short soft hairs are used by the natives as fertiliser or for making ropes.

After being scraped off, bristles are combed to remove impurities, etc., and are sorted into bundles about 1½ in. in diameter, containing bristles of uniform length. This work is done principally by Chinese women earning about 2*d*. a day.

Bristles are judged as to length, thickness, lustre, stiffness, and admixture of foreign matters, and are graded into lengths, varying by quarter inches, from 2 in. to 6 in.; but in Shantung the lengths 2¼ in. and 5¾ in. are not sorted separately. Bristles that are long, thick, stiff, bright, and clean fetch the highest prices. Practically all the bristles in Shantung are brought to the vicinity of Weihsien to be prepared for shipment to the point of export.

The shops near Weihsien send buyers to all parts of the Province of Shantung to collect bristles, for which they pay from 3*d*. to 2*s*. 6*d*. per lb., unsorted, the average price being about 2*s*. Most hogs are slaughtered from October to March, and bristles are exported in greatest quantities in March and April.

While the different length of bristles may be bought as desired, they are commonly combined in fixed proportions, a certain quantity of each length being included in each assortment.

Bristles have hitherto been exported mostly to Germany, Great Britain, the United States, and France. The largest exporting firms have been all European—five German, two French, and one British. Sometimes these firms send compradores (native managers) to the Weihsien district to deal directly with the shops; but by far the greater part of the purchasing is done through Chinese brokers in Tsingtau. The latter do a brokerage business only and charge 2 per cent. The compradore receives the same commission. Five per cent. of the price is paid when the contract is made, and the balance on delivery of the goods. Charges on goods, *i.e.* freight, packing, etc., amount to about 12*s*. per 100 lb. between Weihsien and Kobe (Japan). The foreign firms, on receiving bristles from the interior, wrap them in paper bearing their own trade-marks, and pack them in camphor in matting-lined boxes.

All of the European firms except the British have ceased doing business in bristles in Tsingtau since the military operations took place. Consequently, dealers are shipping more through Tientsin. The amount shipped from Tsingtau in 1915 was less than half of that shipped in 1913.

It is estimated that there are 800,000 grown hogs in Shantung Province, and that 600,000 are slaughtered annually. Since each hog yields about 1¾ lb. of bristles, the export is only about two-thirds of the production. Large quantities of bristles are shipped from the neighbouring Province of Honan by railway to Tientsin. When the Shantung Railway is extended, in a short time, toward the west, this trade can be diverted to Tsingtau, and the future of the business seems bright.

EXPERIMENTS WITH BRINES IN SEARCH FOR POTASH.

Several deep holes have been sunk in the deserts of Nevada, and one is being drilled in Texas, under the supervision of the United States Geological Survey, in the search for potash. The Survey is also making some laboratory experiments designed to aid in discovering a cheap process of separating potassium salts from natural brines.

Since the importation of potash salts from Germany was stopped, the urgent need of a domestic supply has greatly increased, and the price of high-grade potash has advanced from £8 to about £100 a ton. Efforts to find commercially workable deposits in the United States have been eagerly and diligently made, both by private capitalists and public agencies. The Survey has endeavoured both to find deposits of soluble potash salts and to discover practicable methods of extracting potash from rocks that carry relatively large proportions of potassium. Every clue that might yield valuable results has been followed up in a country-wide investigation, extending from New York to California.

In the laboratory experiments special attention has been given to the evaporation of brines rich in potassium. The results of some of the earlier work were published late in 1915. More recent experiments have been made with the natural brine from Searles Lake, California, which contains the equivalent of nearly 12 per cent. of potassium chloride in the solid salts. The results are given in a recent Survey publication, entitled "Evaporation of Brine from Searles Lake, Cal." This report shows the changes in the composition of the solution resulting from the evaporation of the brine, the composition of the crystals deposited from the hot solution during evaporation, and the composition of the crystals deposited when the solution was cooled. A copy of the report may be obtained free of charge by addressing the United States Geological Survey, Washington, D.C.

The data recorded indicate that carefully controlled fractional evaporation and crystallisation, possibly combined with other treatment, promise much as a means of obtaining potassium from

brines similar to that of Searles Lake. Further study of the behaviour of the constituents of the brine under varying conditions may be made.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Fast Colours.—Despite the shortage of dye-stuffs, a few British manufacturers have been able to produce with fair continuity coloured cottons in a limited range of shades warranted in fastness against washing and sunlight. They had access evidently to supplies of the "vat colours" manufactured from anthraquinone, and the source of these supplies has been somewhat of a mystery. The main source in former days was the Badische Company, which gave the name "indanthrene" to these useful colours, the fastest known dyes for cotton, and appreciably more permanent than such vat colours as are made from a base of indigo. It seems that in a small way these colours had been manufactured on Cheshire soil by the German company before the war. By February, 1915, indanthrene was being produced by the Morton Sundour Fabrics, Ltd., of Carlisle, for use upon their own curtains and cloths, and for the use of a few other textile manufacturing concerns. Messrs. Claus & Co., Ltd., of Clayton, Manchester, have produced, under the name "duranthrene," blues and olive, of which large quantities have been supplied. The chloranthrene blue of British Dyes, Ltd., is the same colour under a distinctive name. These advances have been made in the face of considerable difficulties, and the success of three firms in what had hitherto been a purely German domain is a sign of good augury. It was conceded by the enemy that England might make the common colours, but our colour-makers were not expected to master the production of indanthrene within ten years.

Scientific Aid.—Probably the greatest aid rendered by organised science to textile industry is that which is applied when things go wrong. The man of science is summoned to tell the man of practice why the results have not fallen out as they always did before, or to suggest how some desired end can be reached. The chemist succeeds at times and fails at others, but without his aid there are innumerable small operations which could not be repeated with certitude, and very many processes which could only be performed at more expense. This being so, it is not the wisest policy to claim for science discoveries that have certainly empirical origins. The mercerisation of cotton and the recovery of grease from soapy water are claimed in a recent pamphlet as results of the application of science to industry, but such pretensions weaken and obscure the real case. Textile industry owes remarkably little to science in the way of large discovery, but the debt to science in facilitating tasks already undertaken is greater than is generally realised or acknowledged. The story of what scientific help has actually achieved, together with specimens of the difficulties waiting to be solved, would not be less effective in opening the minds and purses of manufacturers than any cruder and less tenable claims.

Paper Uniforms.—It seems certain from samples received in this country that German troops in the field are wearing uniforms composed of 40 per cent. of twisted paper, 40 per cent. of cotton, and 20 per cent. of wool waste or shoddy. This composition is certainly not affected from choice, and no good result attended German efforts to market tweeds made of wool and paper some half-dozen years ago. Passable-looking suits can be made with woollen and paper yarns alternating two by two, although their tendency to crease in wear and lie heavy in the hollows of the figure is perceptible. Naturally, the fabric is not improved by wetting, and because water is fatal to it manufacturers hesitate to employ paper thread even for the backing of cheap carpets. These snatches of cloth are one proof of dire straits, and the significance of their use as army clothing is not lost upon the minds of wool manufacturers in this country. Want of wool is believed to be not the least of the influences depressing and embarrassing the enemy and tending to bring the war to a close.

Hand Weaving.—The hand loom has lingered on in the woollen mill as a convenience for weaving short pattern lengths, but even in that capacity it is being replaced by fast power looms. It may be long before the hand loom disappears from the factory, for in rare cases even the hand mule survives, and serves the purpose of spinning trial lengths of yarn. The gradual disappearance is noted, however, by greybeards who worked at the domestic loom in their youth, and carried the raw and woven materials to and from the factory. The time lost in conveyance is one of the matters especially remembered, and there is no reason to doubt that this inconvenience was a prime cause of the concentration of looms in factories where they could be run by power at a speed which was not initially much higher than that of expert hand weaving. The change is not very sentimentally regarded by the craftsmen, and it is noteworthy that some of them dispute the idea that hand work is any better than power weaving. It is agreed that in general respects hand work is no worse, and that it permits of a more rigorous scrutiny of materials; but the theory that hand work is less mechanical than the crank-driven loom receives little support from experience. There are men, apprenticed to the hand loom, who are disposed to champion

machine work against all comers, and to make light of the factor of individuality that personal effort is supposed to bestow. A certain individuality of rhythm of movement is admitted, and bodies of hand-loom weavers working together come to identify particular weavers by the sound of their looms, exactly as one recognises footsteps; but it is even vehemently denied that personal characteristics—at any rate, of a beneficial kind—are transmitted to the woven cloth.

Flannel.—An American Court has laid down a definition of flannel which in at least two particulars varies from English understanding. It gives somewhat of a shock to hear that flannel is primarily "a woven men's wear suiting fabric." Flannel suits, dyed and undyed, plain or fancy-woven, are indeed known, but their flannel does not represent the original article as worn in infancy or as a garment next the skin. The definition continues: "consisting of carded soft stock wholly or largely of wool rather loosely woven . . . sold practically in the texture in which it leaves the loom." On this point suffice it to say that English drapers have been successfully pursued under the Merchandise Marks Act for labelling as flannel cloths not all-wool; but in other respects the definition may stand. The New English Dictionary notes, but does not unreservedly accept, the etymology which traces "flannel" to (Welsh) *gwlân*, wool. At any rate, the Welsh flannels are woollen, and the name is associated with Wales in the English mind. Certain "yerdes of fflanell" at one shilling the yard figured in the effects of Princess Elizabeth of York in 1503. A statute of 1606 relative to the true making of woollen cloths points clearly to flannels as articles in which "floxe, thrumes or Lambes wool" might be permitted. "Flannell Wadnall and Coverlets or Blanketts" might be made "in such sort as has heretofore been lawfully used and accustomed." Wadnalls are not familiar articles in these times, but their name may be thought to betoken some ancestor of the stuffed quilt.

Russian Trade.—Many eyes turn towards Russia in the expectation of large business after the war, and regret is expressed over the temporary difficulties of transport which limit and even forbid shipment of yarns and cloths at present. Russia has a considerable textile industry of her own, but according to recent advices 60 per cent. of the cottons and 75 per cent. of the woollens currently produced are consumed by the Central Government, the municipalities and zemstvos, and their hospitals. Stocks of goods are lower than was ever known, and money is more plentiful among the peasantry than at any earlier period. The mills in Poland, now occupied by the enemy, had a large trade with Russia, and their defection contributes to the shortage of supplies. An emissary of an American manufacturers' organisation reports that in 1912 there were 261 textile industrial companies in Russia, but much larger numbers of mill premises are recorded in the factory inspection returns.

GENERAL NOTES.

Bauxite Deposits in France.—In an article entitled "Un Grand Marché Français à reprendre aux Allemands," which recently appeared in a Nice journal, *L'Eclaireur*, mention was made of the important deposits of bauxite at Luc, in the Department of the Var, about 75 miles from Nice on the main line of railway to Marseilles. The ore, which is of a reddish colour, due to the presence of iron oxide, contains a large percentage of oxide of alumina. Before the war the whole output of mineral from these workings, which was considerable, was chiefly sent to St. Maxime, a little port on the Gulf of St. Tropez, and also to Nice or Toulon, for shipment to Germany, where the aluminium was extracted and returned to France in the manufactured state. It is to be hoped that after the war this practice will no longer obtain, and that kitchen utensils, and other articles of aluminium, "made in Germany" will no longer flood the home markets. Surely, with the unlimited water-power available, or *houille blanche* ("white coal" as it is fancifully called), the mineral resources of the district could be profitably utilised by modern electrical processes of extraction. Other deposits of this mineral are to be found in the South of France, notably those at Baux (hence the name "bauxite"), in the Department of the Bouche du Rhône. These mines are situated on the southern slopes of a range of hills called "La Chaîne des Alpines," about ten miles north-east from Arles and a short distance south of the village and railway station of St. Rémy.

Tobacco in Ontario.—About seven million pounds of tobacco is now being grown annually in Ontario, and the rapid expansion of the industry during the last few years has, according to *United Empire*, necessitated the appointment, by the Dominion Experimental Farms Tobacco Division, of three experts from the tobacco belt of the United States. One is to take charge of the laboratory at Ottawa; a second is charged with the investigation of the tobacco soils of the various districts, and with problems of culture, fertilisation, and curing of the tobacco crop; and a third with investigations regarding the varieties best suited to the Canadian climate and market, the best methods of handling the crop under existing conditions, and all problems connected with the production of tobacco. The assistance of these experts will be available to any farmer.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 10th, 3 p.m. (Juvenile Lecture.) Mr. ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications." (Lecture II.)

The lecture will be fully illustrated with numerous experiments.

Further particulars of the Society's meetings will be found at the end of this number.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

JUVENILE LECTURES.

On Wednesday afternoon, January 3rd, Mr. Alan A. Campbell Swinton, F.R.S., delivered the first lecture of his course on "Electricity and its Applications."

The lecturer began by remarking that electrical phenomena had been observed as long ago as 600 B.C., when Thales of Miletus noted the electrical properties of amber; while Pliny, in A.D. 60, recorded that jet possessed similar properties. Gilbert, physician to Queen Elizabeth, discovered other substances with these qualities in addition to amber and jet, and in 1647 Otto von Guericke of Magdeburg invented his well-known frictional electric machine in which he used sulphur. A picture of the apparatus was shown on the screen.

An interesting story was related showing one of the preliminary steps to the discovery of the Leyden jar. Cuneus of Leyden was trying to electrify some water in a bottle. For this purpose he held the bottle in one hand, his hand thus forming an outer coating to it. He had previously placed in the bottle a nail connected with the electrical machine. When he thought the water was sufficiently electrified, he endeavoured, with the disengaged hand, to remove the nail. The result surprised him, and Muschen Broek, his master, on repeating the experiment, received so great a shock that he lost consciousness, and was so frightened that he afterwards wrote that for nothing in the world, not even for the crown of France, would he go through it again. Happily, other physicists were less fearful, and continued to work at the experiment which ultimately led to the modern Leyden jar.

Having briefly referred to the parts played by Franklin, Volta, Galvani, and others in the development of electrical science, Mr. Campbell Swinton proceeded to give a series of interesting and beautiful experiments. He showed the process of decomposition of water, electroplated silver and copper coins, and repeated the experiments of Faraday which led to the evolution of the dynamo. Among some remarkable photographs thrown upon the screen were two taken by Professor Boys: the first was of an electric spark, showing that its duration was about $\frac{1}{1,000,000}$th of a second, and the other of a bullet travelling at 2,040 feet per second, taken by the flash of an electric spark.

The concluding series of experiments dealt with the phenomena of high-frequency induction. Disconnected electric lamps were lighted; a gas jet was kindled from the lecturer's finger; the power of induction between large hoops of copper was demonstrated; and, finally, some beautiful illustrations were shown of the remarkable colour effects seen in the spiral-wound vacuum tube.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

COAL AND ITS ECONOMIC UTILISATION.

By John S. S. Brame,
Professor of Chemistry, Royal Naval College, Greenwich.

Lecture I.—Delivered November 27th, 1916.

The economic importance of coal we perhaps hardly realise. It is the only raw material we produce in great quantity; the value of our total mineral output in 1913 was over £160,000,000; of this the value of the coal at the mine was over £145,500,000. Next in importance came iron ore, but the quantity produced was only one-eighteenth that of coal, its value but little over £4,500,000.

The great value of coal to us lies in its universal application—for power production, for metallurgical purposes, for providing us with heat and light, for furnishing as by-products in its distillation some of the most valuable materials in the realm of chemical products.

On coal the industrial greatness of Great Britain has been built up. On coal we must depend for the maintenance of our industrial supremacy. The use of coke for smelting our iron ores gave the first big impetus to the increasing production of coal. Cheap coal meant cheap iron and steel. From cheap iron and steel we may trace the development of our big engineering output, and, when iron and steel replaced wood, of our immense mercantile marine. Coal provided the source of power for driving the machines we made by the use of coal, and gave rise to the great textile and other industrial concerns which have made us one of the greatest and richest manufacturing nations.

No less true is it that coal has been the important factor in the development of that great Navy on which to-day we place our reliance. By the aid of coal we have produced our iron and built our ships and guns, and, though oil fuel plays no small part in driving them, still our smokeless Welsh coal is perhaps as valuable an asset to us as ever.

In the arts of peace coal is invaluable to us; no less valuable is it to us in the science of war. Coal may truly be termed *the* munition of war. I cannot bring before you its importance in words of my own which are half so forceful as an utterance of Mr. Lloyd George in the early part of the war:—

"In times of peace coal is the most important element in the industrial life of the country. In peace and in war King Coal is the paramount lord of industry. It enters into every article of consumption and utility. It is our real international coinage. We buy goods abroad—food and raw material. We pay, not in gold, but in coal. In war it is life for us and death for our foes. It not merely fetches and carries for us, it makes the material and the machinery which it transports. It bends, it moulds, it fills the weapons of war. Steam means coal. Machine-guns mean coal. Cannons mean coal. Shells are made with coal. Shells are filled with coal. The very explosive inside them is coal, and then coal carries them on right into the battlefield to help our men. Coal is everything to us, and we want more of it to win victory. Coal is the most terrible of enemies and it is the most potent of friends."

To quote Mr. Asquith: "The importance of coal in the great national and international struggle in which we are engaged is only exceeded by the importance of men."

Not only is coal of importance to us as furnishing the fuel for the production of iron and steel, for providing the power to drive our great factories busily engaged in the production of munitions, for providing power for our Navy and great fleet of transports, but the by-products from its distillation form the raw material for our high explosives, for the purpose of defeating our enemies; for many valuable preparations for the treatment and alleviation of the sufferings of our wounded; for disinfectants, for photographic materials, and other purposes directly connected with the war.

Coal, indeed, may be regarded as the black diamond without which the silver bullet is useless.

One of the most urgent problems of the war has been the maintenance of the output, in the face of difficulties arising from reduction of labour. Up to the end of June, 285,000 miners had joined the colours. At the present time there is a shortage of 153,000 men, or 14 per cent. of the normal number engaged in coal-mining.

But in these lectures we are more specially concerned with the future. We all realise that our stocks of coal are not inexhaustible, that our consumption has gone up by leaps and bounds, that we have been shockingly improvident in the production and use of this invaluable mineral. The movement for economy which is now being energetically conducted is no new movement; many eminent men have appealed for economy, and up to the present largely in vain. Professor Jevons' book on the coal

question, published in 1863, led to the appointment of the first Royal Commission, which published a report in 1871. More recently we have had the report of the second Commission (1905).

Among the eminent men who have tried to force the question on the attention of the nation was the late Sir William Ramsay, who made it the subject of his Presidential Address to the British Association. Again, at the fourth annual meeting of the British Science Guild, he drew attention to "the waste of the natural sources of energy of the Empire," and a committee afterwards furnished a valuable report on the subject.

I fear, however, that much of what was done in the past was in the nature of appealing to the converted—a small, if select, audience. Better fortune may befall the movement which has been so energetically started since the war, largely by Professors H. E. Armstrong and W. A. Bone. In his characteristic trenchant manner, Professor Armstrong has endeavoured to galvanise the industrial chemists into action, as being those having the knowledge which carries with it the right to demand Government action. His recent constructive addresses to sections of the Society of Chemical Industry are worthy of most careful study. Before the Newcastle Section his thesis was on "The problems of coal with reference to the complete and provident utilisation of the supplies and of fuels generally: a preliminary discussion and scheme" (*Jour. Soc. Chem. Ind.*, 1916, 35. 220). At the annual meeting last July, Professor Armstrong laid before the Society further views on the question under the title "Fuel Economy: a national policy required" (*Jour. Soc. Chem. Ind.*, 1916, 35. 765).

Professor W. A. Bone has also been most energetic in pushing this truly "burning" question. In addition to initiating a valuable discussion before the London Section of the Society of Chemical Industry (*Jour. Soc. Chem. Ind.*, 1916, 35. 389) and the Nottingham Section (*loc. cit.* 674), he has delivered himself more fully at the Royal Institution. Through his energetic action the British Association was led to appoint a Committee on Fuel Economy, which includes many men particularly well able to deal with the problems set aside for the consideration of the various sub-committees on which they serve. These are: (*a*) Chemical and statistical; (*b*) carbonisation; (*c*) metallurgical, ceramic and refractory materials; (*d*) power and steam raising; (*e*) domestic heating and smoke prevention. A preliminary report was furnished this year, and there can be no doubt that the information which the various sub-committees have set out to obtain will prove of the greatest value in paving the way for future action.

The first step towards the realisation of economy in the production and utilisation of coal is to convince the more thoughtful members of the community of the necessity. They must be taught that not only are enormous economies possible, but that economy *will pay*, in many cases quickly, in every case before the lapse of many years.

The improvident use we have made of coal has been in great measure due to its cheapness. The great public has remained untouched by the appeals of scientists, who have addressed scientists already convinced. The war has brought the coal question home to the more thoughtful members of the community; the prominence which the by-products have assumed as raw materials has forced them to realise that coal is not something merely to be burnt.

Valuable as the results from the British Association Committee promise to be, and of the discussions before the Society of Chemical Industry and other societies, individually they cannot carry the weight which a united action on the part of the scientific and technical societies would. The Royal Society of Arts, with its traditions and with over a century and a half of useful work as an educational institution, should take a prominent place in this movement. It is because of the pressing importance of the coal question, and because I hope to see this Society lending the powerful weight of its educational advantages and its prestige to advancing the movement, to making it a problem to be dealt with and not shelved, that I have chosen this question for this course of lectures, in the hope that this Society may take action in conjunction with others.

Turning to our output of coal and our home consumption in the year 1913, a period undisturbed by domestic troubles or by the war, we touched high-water mark in production, and in consumption, with an output of 287,430,000 tons, of which 189,000,000 tons were retained for home use. The number of employees was 1,110,884, which gave an output per head of 259 tons.

With the outbreak of war our production quickly fell off. The response of the miners to the country's call by joining the colours has been so splendid that in 1914 the output fell to

265½ million tons; in 1915 to 253 million tons. The demand for coal, however, increased with the enormous activity in the production of munitions, but the home consumption in 1914 was 184½ million tons, and about the same figure for 1915. It was therefore the export trade which suffered.

The industrial rise of Great Britain, as measured by the coal barometer, and also our export trade, may be seen from Fig. 1, showing the quinquennial output and export from 1871 to 1915:—

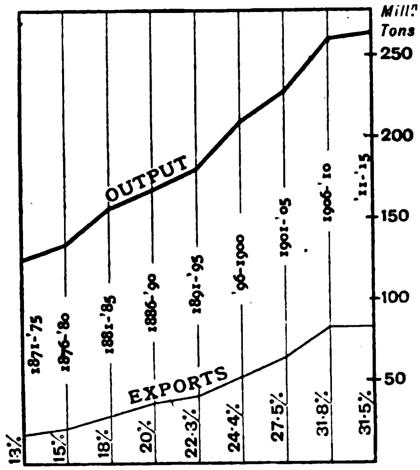

Fig. 1.—Production and Export of Coal, 1871-1915.

In the period of forty-two years, from 1873 to 1914, we have raised 8,206,243,000 tons, and exported 2,012,796,000 tons, or more than 24½ per cent. The value of the coal raised was equal to over 84 per cent. of the value of our whole mineral output.

But to grasp the importance of the coal problem, we must study it in relation to our greatest commercial rivals. In the middle of the last century, small though our output was in relation to the present output, it was by far the largest in the world. The United States and Germany have, however, increased their rate of production per annum at a much greater rate than we have; since 1876 the United States output has doubled itself in every twelve or thirteen years, until now it is nearly twice as great as our own. Germany has also gained rapidly upon us, her average output for the five years 1910–14 was practically the same as ours for the period 1886–1890.

The striking character of these developments in production in these three greatest coal-producing States will be seen from Fig. 2.

It is difficult to estimate the consumption of coal in the various industries; but the 1905 Commission published figures which they regarded as approximately correct for the year 1903, when the consumption was 167,000,000 tons. These figures may be brought up to date *pro rata* without serious error being involved, as the proportions will have altered to a less extent than the probable error in computation. Taking an average consumption just prior to the war of 187,000,000 tons, the figures are:—

	Million tons.
Railways (all purposes)	15·0
Coasting steamers (bunkers)	2·5
Factories	60·0
Mines	20·0
Iron and steel industries	31·0
Other metals and minerals	1·0
Brick works, potteries, glass works, chemical works	6·0
Gas works	16·5
Domestic	35·0
Total	187·0

Having considered our output and consumption the question arises naturally, what stocks have we, what inroads have we made on them, and how long will the stocks last?

The last is too highly speculative and has too little real bearing on the question of economy to justify more than a reference to the insuperable difficulties of making such an estimate. It rests on undeterminable factors, such as the probable rate of increase of consumption per head of population, the rate of increase of population, the possible decrease in our export trade as other countries develop their export trade—notably the United States. The effect which the great war will have on these factors, notably population twenty years hence for example, cannot be gauged.

Estimates of stock can, however, be made with some approximation. Both the 1871 and 1905 Commissions took 4,000 ft. as the limit of depth for workable coal. Deeper mines are known, but working expenses necessarily mount up rapidly as greater depths are reached. The shaft is more expensive and the cost of winding, roads are more difficult to keep open, the quantity of crushed coal is considerably increased.

The thickness of paying seams depends on a variety of factors. The Commission took a minimum of one foot. Then deduction must be made for coal which must be left as barriers, supporting pillars, etc. This is very variable in

different fields, but the average figure of 22·7 per cent. was adopted. On this basis the following estimate was made, the figures being in million tons :—

ESTIMATED COAL RESERVES, ROYAL COMMISSION, 1905.

	Not exceeding 4,000 ft.	From 4,000-10,000 ft.
Proved	100,914	5,239
Unproved	40,721	—
Totals	141,635	5,239

Certain important districts where coal was known to exist were not included, as the data were doubtful. These included Kent, and probable extensions of the Gloucester and Somerset fields and of the Cheshire basin.

A few words may prove of interest about the Kent field, which is of particular interest to us in London and of wider importance because of its geographical situation in relation to the North Sea and Channel.

Dr. Aubrey Strahan, of the Geological Survey, put down the probable reserves of Kent as 2,000 million tons, which Professor H. S. Jevons considers far too conservative an estimate. According to him, from borings which have gone to 2,500 ft., it is established that over an area of 150 square miles the total thickness of the seams (of 18 in. and over) is from 30 to 40 ft. If the area is no greater than this, and there is reason to believe it is much more extensive, the reserves would be some 6,000 million tons.

Much of the coal, however, is very soft; at least, this is so in the upper seams, so that the percentage of large coal is not high. At greater depths excellent hard coal is obtained. From

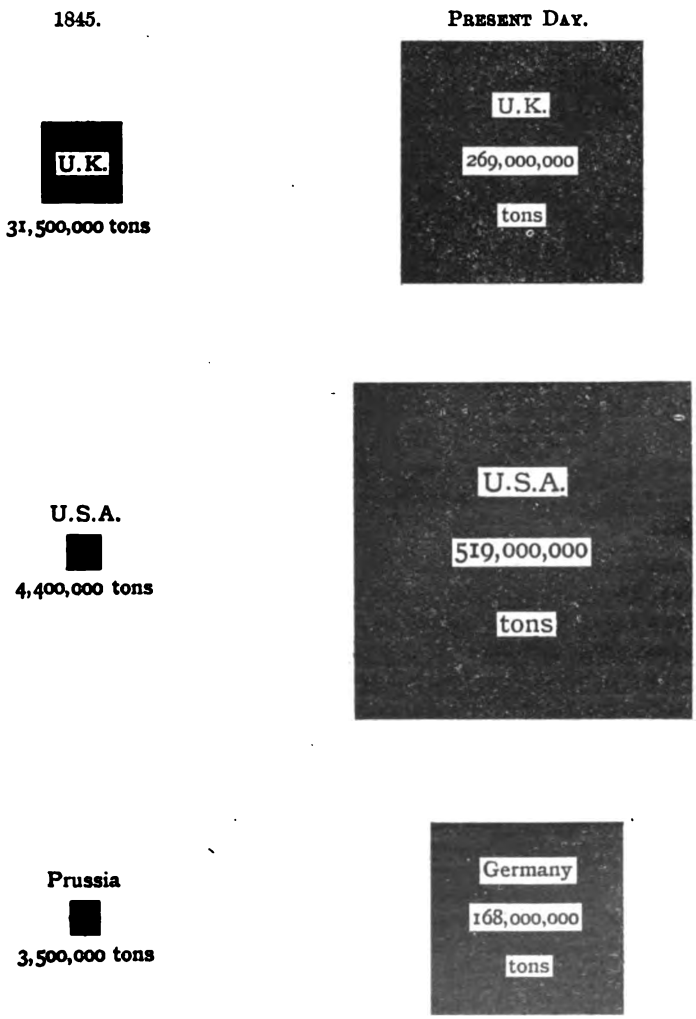

FIG. 2.—OUTPUT OF COAL, 1845 AND PRESENT DAY.

samples taken from borings it may be concluded that three distinct classes of coal are found, the average composition for the pure coal substance (*i.e.* free from ash and moisture) being as follows:—

Carbon.	Hydrogen.	Sulphur.	Nitrogen.	Oxygen.	Volatile constituents.
86·5	5·10	1·21	1·04	6·1	28·5
87·8	4·76	1·18	1·06	5·1	22·0
90·0	4·44	0·92	1·02	3·4	15·6

It may be noted that the composition of the last class is very close to the average composition of the high-class Welsh smokeless coals. If the burning qualities of the coal are as good, and the seams are workable, the occurrence of such coal so conveniently situated in relation to several important naval bases may prove a valuable asset to the Royal Navy, and the nation might well consider the question of reserving these beds, for, in spite of our extended use of oil fuel, smokeless coal is, and will continue, in great demand.

To return to the probable coal reserves of this country and Dr. Aubrey Strahan's estimates, we have the following:—

	Not exceeding 4,000 ft.	From 4,000 to 6,000 ft.
Actual reserves . .	133,117	6,108
Probable and possible	45,610	1,659
Totals . . .	178,727	7,767

I think it is safe to take the coal reserves not above 4,000 ft. deep at the round figure of 180,000 million tons.

Comparison may now be made between our reserves and those of other countries. For this purpose we may turn to the valuable statistics relating to the probable coal reserves of the world, compiled for the International Geological Congress held in Canada in 1913. The returns were made in metric tons, so that for a proper comparison with British official returns these have been converted to Imperial tons. The following figures are given for Europe:—

	Million tons.
Germany	415,794
United Kingdom	186,153
Russia	59,079
Austria-Hungary	58,211
France	16,270
Belgium	10,803
Other Countries	22,926

It will be seen that Germany possesses 54 per cent. of the whole; Great Britain, 24 per cent.; Russia and Austria-Hungary about 7·6 per cent. each; and France, 2·1 per cent.

But the coal reserves of Europe are only approximately one-seventh as great as those of North America, the bulk of which coal lies in the United States, although Canada is fortunate in having considerable supplies (over 1,100,000 million tons). The following table shows the estimated reserves of the world:—

ESTIMATED COAL RESERVES OF THE WORLD.

	Million tons.
North America	5,023,760
Asia	1,256,690
Europe	770,170
Australia	167,600
Africa	56,800

Of the world's probable reserves, then, North America can claim nearly 69 per cent., of which, approximately, 40 per cent. lies in the United States. Asia comes next with 17·3 per cent., leaving Europe a poor third with about 10·5 per cent.

We are now able to consider our position in relation to that of our nearest commercial rivals. Broadly, the manufacturing activity of the great nations may be gauged by their coal consumption. Taken in relation to their probable reserves, the output of the three largest coal-producing countries is as follows:—

	Output in million tons (1910-1914).	Probable reserve in million tons.	Percentage of output to reserves.
United States	519	4,000,000	0·013
Germany .	168	415,800	0·040
Great Britain	269	186,600	0·140

In round figures the percentage of the output which is retained for home consumption is:—

United States	over 90 per cent.
Germany	75 „
Great Britain	67 „

Not only are we exhausting our supplies at a far higher proportionate rate than our nearest commercial rivals, but we are retaining for our home use a much smaller proportion of the output.

It is not a question of the exhaustion of our coal supplies, but of the time when our easily and cheaply won coal has, to a large extent, been used up and coal is becoming relatively dearer in relation to other commodities and to the cost of production in rival countries. They

must also expect to meet with a rise in cost of production, but the greater the reserves in relation to the output, the further off is this period of marked rise of prices likely to be. More particularly should our position be considered in relation to the United States, beside whose reserves ours are relatively very small, and whose enormous deposits of iron ore place it in a most favourable position. Another factor which must react in favour of the United States, as compared with Europe is the effect of the war, which, whilst depleting the wealth and population of European countries, adds greatly to the comparative resources of the United States.

Already in this country the cost of coal has been rising very appreciably in the last few years; before the war period it was some 25 to 30 per cent. dearer at the pit than ten years previously. As the workings get deeper the cost of shafts, of winding, of maintenance of the roads, all increase. Wages are continually increasing, and legislative action, necessary for the safety of the miners, becomes more stringent and adds to the cost of production.

It is clear that if Great Britain is to maintain her place among the great nations she must remain a great manufacturing centre, and this depends entirely on cheap fuel. The necessity for economy in place of waste is apparent, and enormous economies are undoubtedly possible. The Royal Commission (1905), from figures supplied by Mr. Beilby, estimated that a possible saving of from 20 to 30 million tons might be effected in the consumption for power purposes alone. Quite a conservative estimate of savings which might reasonably be achieved would amount to 50 million tons annually. In production there is much inevitable waste, but there can be no question that very large quantities of coal might be saved by better methods of working and in preparation of the small coal for the market.

So closely, however, is the coal question interwoven with our industrial life, that it fairly bristles with economic difficulties. Following well-recognised trade laws, if economies in production and in use keep coal cheap, industries dependent on coal flourish and the demand for coal consequently increases. This, of course, indicates present prosperity, due directly to the avoidance of waste and so adds to the national wealth; but coal economists who look to avoidance of waste as contributing to the conservation of our stocks are apt to overlook this important compensating effect.

One very important and very difficult question is that of export. As has been shown, our export trade has rapidly increased until in the period just before the war we were sending out of the country one-third of our output. It cannot be denied that in our export trade we have, to a large extent, developed our industrial greatness. It has given us supplies of other raw material for our factories in exchange; it has determined largely the growth of our great mercantile marine. As Mr. Lloyd George said: "We buy goods abroad—food and raw material. We pay, not in gold, but in coal." To quote Mr. Asquith: "Coal is our chief and in many ways our most necessary export. It helps to feed the country by bringing in food from abroad. It helps to pay for the war. It assists, perhaps more than any other commodity, in keeping up the rate of exchange."

But we must look at this question of export on a wider front than the immediate present or the immediate future. It is perhaps not realised that in the last five years prior to the war we reduced our reserves through export by the equivalent of two years' consumption; that in the period of forty-two years—1873-1914—we exported in all 2,012,796,000 tons of coal. If, as our political economists tell us, our export is essential to our well-being, we must realise that it is at the cost of bringing the day rapidly nearer when industries will be hampered by dear coal—in other words, mortgaging the interests of posterity in the interests of the present, and possibly a few succeeding generations; and I doubt whether the blessings of posterity will fall on the economical system which permitted this.

One realises that this is a thorny subject; it is evident that no drastic interference with our export of coal is possible, but, as pointed out by the Royal Commission of 1871, "a time must be anticipated when it will be more economical to import part of our coal than to raise the whole of it from our residual beds, and before complete exhaustion is reached the importation of coal will become the rule and not the exception of our practice." Our plain duty is to consider this question very carefully in all its manifold ramifications in order that the evil day of importation may be postponed as long as possible. Certainly the export of this essential commodity which cannot be replaced, and for which no adequate substitute is likely to be found, should be made contributory to the provision of means for meeting the future requirements of the nation

and maintaining its prosperity when we cease through natural or other causes to be exporters.

The suggestion which has been made for the re-imposition of a duty on export coal, the proceeds from which should be applied to the investigation of our coals and the development of schemes for the more economical utilisation of the coal we consume, would appear very sound.

Exportation and the nationalisation of our coal supplies must become great issues to be decided some day. Sooner or later I feel convinced that a leaf will have to be taken from the book of the extreme Socialist, who wishes to tax large fortunes out of existence. Coal exports will be gradually taxed out of existence; but the process must be very gradual because of the dislocation of an economic system which has been the means of bringing great wealth to the nation, but of which wealth future generations will not inherit sufficient to compensate them for their loss of cheap fuel largely through our prodigious exports.

Again, coal is the principal natural wealth of the nation. Under our system it has been handed over to private interests to exploit in an unrestricted manner (except by legislation affecting the safety of the workers), and the nation has inalienable rights to demand that it shall not be recklessly expended or sold for gain (often to the great advantage of commercial rivals) without the nation profiting by the transaction in such a way that its future prosperity is, as far as possible, provided for in other ways.

The cheery optimist, however, does not worry over this question, even if he realises the grave issues involved. He relies on the scientist "discovering something" before our coal is running short, and so saves himself the trouble of considering the question. But what are the alternatives to coal, and what are the prospects of some great discovery? The British Science Guild published some careful considerations of the alternatives which might be open to us. Oil fuel is not produced throughout the whole world in sufficient quantity to furnish more than a fraction of the fuel required; moreover, it must always be an imported fuel in this country. In water-power we have no great possibilities; until some more efficient form of storing energy is available, the enormous resources in the winds are of no help. The great energy of the tides and waves would entail an enormous expenditure, and some very difficult practical problems would have to be solved. The enormous potential forces set free by atomic disintegration would, in the opinion of the late Sir William Ramsay, not be capable of replacing fuel or water-power—it could not pay. Underground heat, according to the Hon. R. J. Strutt, will not prove the solution. In fact, there is no alternative in sight, and we must rely on the utilisation of our coal in the most economical manner which scientists, engineers and manufacturers can devise.

Even if other sources than the above were available, we should not possess them in relative advantage to others; indeed, in many instances, we are distinctly at a disadvantage.

In discussion on coal economy I do not think sufficient weight is given to what has already been accomplished. We have indeed made very considerable progress, but that by no means implies that our efforts should relax. Rather does it emphasise the cases where improvident use of coal still continues, and point the way for fresh advances. Much more small coal is brought to bank, and rendered good serviceable coal by proper preparation for the market, or for use in coking plant. We have made substantial progress in the replacement of the wasteful beehive coke ovens by systems which are more economical and give us the benefit of the by-products; our gas producers have made considerable strides in producing gas with a much smaller works consumption of fuel, and in extending the use of gas and coke for industrial and domestic heating. In all our larger steam-power producing concerns, by the introduction of mechanical stoking, of water-tube boilers and notably of turbines, very considerable reduction in fuel consumption per unit of energy has been achieved. Lastly, the more general introduction of plants for gasifying coal and schemes for the utilisation of waste heat from coke ovens and blast furnaces have resulted in noteworthy economies in use.

The rise we have experienced, and the future enhanced cost of coal which we must expect, may prove the most important factor in promoting economy. Because coal has been cheap it has not paid to study economy.

Professors Armstrong and Bone have laid great emphasis on demanding Parliamentary action. But I believe it is to sound commercial enterprise that we must look for the greatest economies in the use of coal. Parliamentary action in this direction can only be indirect — in making provision for a national fuel-testing station, where large scale investigation on our different

coals and the most suitable ways of economically using them may be carried out; by financing research work in relation to the composition of coal, and the scientific principles involved in its application; and in general encouragement of technical education throughout the technical schools of the country on coal and fuel economics.

The nation certainly has the right to demand direct Parliamentary action for preventing wasteful methods of production; for dealing with coal left underground, either as necessary barriers, supports, etc., or because at present it is more remunerative to the owner to bring to bank only the best of the coal; for insisting on the working of thinner seams or poorer seams which have been left for similar reasons. But I do not believe Parliamentary action can ever be stimulated for such a scheme, as suggested by Professor Armstrong, as the prohibition of the use of raw coal for domestic purposes after a given time limit, or for the total prohibition of the use of raw coal for industrial purposes generally, as some enthusiasts have advocated.

On cheap coal England's commercial greatness has been built up; the day when coal in this country becomes relatively dear will mark the commencement of the restriction of some of our greatest industries, notably iron and steel. To maintain our position we must stave off this evil day; we must consider every means of economy in production and use. If necessary, and I think there can be no question of the necessity, we must gradually restrict our export of coal, and must rely upon something other than this export of the blood from the country's commercial arterial system for the maintenance of our foreign trade.

As Professor H. S. Jevons so aptly puts it, "Englishmen must take heed in the future to rely less upon exploiting our vast stores of national wealth, and more upon the resources which scientific skill and practical education can place at our disposal."

DEVELOPMENT OF THE KAMERUN.

Kamerun lies between British Nigeria and French Kongo, and extends from the coast northeastward to the southern shore of Lake Chad. In 1913 a considerable tract of land, extending south to the Kongo and Ubangi rivers, was transferred to Kamerun from French Kongo, the new acquisition being known as New Kamerun.

The colony covers an area of 305,140 square miles and, according to the latest estimate, has 2,720,000 inhabitants, of whom 1,550 are whites. Bantu negroes inhabit the coastal regions and Sudan negroes the interior.

The Colonial Government has opened to traffic 105 miles of the Northern Railway (3·28 ft. gauge), from Duala to Nkongsamba, and the central line from Duala to Edea, a distance of about fifty-six miles. A tramway is also in operation from Buea, the capital, to Victoria, the seaport, a distance of twenty miles.

As in many parts of West Africa, the richest natural resources of the colony are in the hinterland, and the lack of transportation facilities to the sea-coast has retarded its development.

It has been proposed gradually to extend the construction of the railway from Duala as far north as Parua, nearly 550 miles inland on the Benue River, so that it would tap all of the northern interior; the Duala-Edea line also was to have been continued to Widimenge on the Nyong River, about 130 miles beyond Edea. A railway from the port of Kampo, near the frontier of Spanish Rio Muni, into the hinterland has also been proposed.

Motor-car lines of more or less importance as transport mediums were established, the one from the port of Kribi to Jaunde, about 200 miles inland, being the most extensive. Considerable attention was given to road construction, with the result that in some parts of the colony good roads between trading posts are found. In the regions more distant from the larger towns, however, the only means of transport are still the caravans composed of native carriers. The chief rivers, the Sanaga, Munga, and Wuri, are navigable by steamers for a distance of thirty or forty miles; beyond that caravans must be employed. As the natives can only carry loads of 60 lb. or 70 lb. for a distance of twelve to fifteen miles per day, and as it takes thirty days to go from Duala to Middle Kamerun and twenty days to Lake Chad, it is evident that few products, except rubber and ivory, can bear this expensive means of transport.

During the first years of German occupation palm oil and kernels were Kamerun's chief products, the exports even exceeding those of rubber. Since 1902, however, rubber has taken predominance, and about one-half of the total exports are now comprised of this product, the value of shipments to Europe having advanced from £546,000 in 1912 to £577,000 in 1913.

According to a report by the United States Vice-Consul at Boma, Kongo, the first attempts at rubber exploitation were made in the northern part of the colony, where the *Landolphia florida*, which was then regarded as the greatest rubber-producing plant, was found. About 1901 the vast forests of Southern Kamerun were discovered to contain great numbers of "kickxia" trees, and the natives were soon set to gathering the "silk rubber" therefrom; but their methods were crude, and resulted in the destruction of so many trees that the move-

ment soon fell off. The rubber crisis of 1912 also caused a decrease in the wild-rubber trade, but at the same time it gave considerable impetus to the establishment of rubber plantations.

Realising that the "kickxia," one of the most valuable rubber plants, was indigenous to Kamerun, the German planters commenced to cultivate it about four or five years ago, and now there are many plantations containing thousands of trees that will soon begin to produce large quantities of first-quality plantation rubber.

The estimates as to cost of production on these plantations compare favourably with those of the Brazilian and East Indian rubber companies. The trees are planted on cleared jungle and brush land and the initial costs are thus small, the average expenses for planting (including labour, implements, etc.), being about £10 per acre. The cost of the upkeep of planted areas is calculated at about 30*s*. per acre for the first year, 22*s*. for the second, 18*s*. for the third, and 10*s*. for the fourth. The trees begin to bear during the fifth year, and it is said that over 1½ lb. of dry rubber may be obtained from a six-year-old "kickxia" tree. The cost of tapping the trees and shipping the product to Europe should not exceed 1*s*. 3*d*. per pound, and, if properly prepared, it is thought that the Kamerun plantation rubber will fetch about the same price as the best Para rubber in European markets. Native labour is fairly plentiful in the rubber-growing districts and costs, including board, about £1 per month. It is likely, therefore, that rubber will remain the most important product of Kamerun for many years.

The gathering of palm kernels and the extraction of the oil therefrom are still important industries of Kamerun. The value of the exports of kernels increased from £210,000 in 1912 to £296,000 in 1913, and of palm oil from £77,000 to £93,000. The trade in palm products is second in importance to that of rubber as to the value of exports. The oil is extracted almost entirely by the natives, whose methods are crude and result in considerable waste. The installation of machinery would add greatly to the importance of the industry.

The cultivation of cacao has attained considerable importance in Kamerun within a very short time. As climatic conditions are similar to those of the Island of Sao Thomé, the well-known centre of cacao production in the Gulf of Guinea, and as a substantial advance in cultivation has taken place during the last six years on the rapidly-increasing number of plantations, the industry has a promising future. The largest plantations are operated by Europeans and are situated on the slopes of the Kamerun Mountains, the total area given over to cacao production being about 26,000 acres, and the number of trees exceeding 6,500,000. The natives have also shown interest in cacao-growing, and many small farms are now found along the Sanaga, Munga, and Wuri rivers. In 1913 the exports of cacao were valued at £246,000, as against £202,000 in 1912 and £157,000 in 1911.

Bananas and other tropical fruits have been shipped to the European markets in increasing quantities, and the widening demand has given a considerable impetus to the exportation of this class of merchandise. Experiments have been made at Victoria in the cultivation of vanilla, ginger, pepper, cloves, and other tropical products. Gold and iron have been found in the colony, but no active exploitation of minerals has taken place.

Not only has there been a rapid industrial development in Kamerun, but the colony has also made considerable commercial progress. In 1904 the total value of its foreign trade was £828,000, whereas ten years later, in 1913, the value was £3,035,000, showing an increase of £2,207,000. The increase in the value of imports during this period was £1,201,000, and in that of exports £1,006,000.

About 80 per cent. of the trade has been with Germany, due largely to the good service offered by direct German steamship lines from Duala and Victoria to Bremen and Hamburg; but the United Kingdom has also done considerable business in Kamerun (about 15 per cent.), as in certain parts of the colony, especially inland, British firms have long been established and have carried on an active trade with the natives.

The principal ports on the sea-coast are Duala, Kribi, Victoria, Rio del Rey, and Kampo; the inland ports, near the frontiers of the neighbouring colonies, being Molundu (in the south) and Garna (in the north). About one-half of the total imports are entered through the custom-house at Duala, while Kribi is the principal port for exportation.

BAUXITE DEPOSITS IN BRITISH GUIANA.

Deposits of bauxite in British Guiana, according to official information, include the following, in addition to those already known:—

1. A substantial deposit in the north-west district of the Colony on the Yarikita River, south-west of its junction with the Amakura River, about twenty-eight miles from the coast at the mouth of the Waini River.

2. A deposit on the Arawari River, which is a branch of the Essequibo River, on the west side, near its mouth. This is fairly convenient for water transportation.

3. A deposit on the Ituna Creek, off the Berbice River, in the direction of the Kwitaro River, a branch of the Demerara River. The mineral from this deposit would have to be taken overland to the Demerara or Berbice rivers. Vessels of 16½ ft. draught can ascend the

Demerara River as far as Wismar, but above this point barges would have to be used.

According to a report by the United States Consul at Georgetown, all of the above-mentioned are on Crown lands, but no Government survey has been made of the deposits; consequently, their extent is not known, although it is believed that mining interests have explored the Arawari and Ituna deposits. The one on the Yarikita River is believed to cover a considerable area, probably extending into Venezuela; but unless the Amakura River is found to be navigable for barges, transportation to the coast would be difficult.

From the location of the known deposits, it would appear that bauxite exists in a strip of territory extending from the junction of the Yarikita and Amakura rivers across British and Dutch Guiana, and probably into French Guiana. The quality of the deposits around Wismar is believed to be equal to that found in the United States and France.

The Commissioner of Lands and Mines, in the course of a letter to an interested engineer, which was published in the local press, stated:—

"There are at present no existing regulations regarding the quarrying of bauxite, but it has been decided that the form of title, if issued, would be a lease to quarry bauxite. The area to be comprised in any one lease is 500 acres. No applications are likely to be approved until the terms on which land is to be leased for mining bauxite are settled by the Government. There is, however, no reason why applications for leases to quarry bauxite may not be made now, by handing in such applications at this Department with the filing fee of $5 (£1) on each application."

A lease which has been drawn up for bauxite lands, but which has not yet been accepted by the Government, provides that the lessees shall pay yearly in advance, without demand, on the first day of January in each year, to the Colonial Treasurer a certain annual rent of 20 cents (10*d.*) per acre or part of an acre, and shall, in addition, pay a royalty of 10 cents (5*d.*) per ton of 2,240 lb. for all bauxite obtained from the lands and exported from the Colony, and the minimum quantity of bauxite upon which, whether exported or not, royalty shall be payable each year shall be the total reached by taking 5 tons for each acre of the lands. The payment under this provision on account of the first year of the lease may be deferred until not later than the fifth year, and the payment on account of any other year of the lease must be made on or before January 10th in the following year. Minimum royalty payments may be averaged over five-year periods.

It is understood, adds the United States Consul, that several applications have been filed with the Department of Lands and Mines for the lease of Crown lands containing bauxite, but no action has yet been taken regarding them, and they are being held pending the decision of the Home Government.

ARTS AND CRAFTS.

Metalwork at St. Dunstan's Studio.—The annual exhibition of Messrs. Omar Ramsden and Alwyn Carr's work (held at their studio in Seymour Place, Fulham Road, S.W.) has been for years one of the shows most eagerly looked for by those who love beautiful metalwork. The exhibition naturally had a somewhat different aspect in war time, and there were more memorial tablets on view, and no large pieces of plate for City companies and the like; but, considering the conditions which are prevailing at present, and the impossibility of getting assistance except from mere boys, there was a great deal of work to be seen and a very fair proportion of it was new since last year. The object which attracted most attention—it was placed by itself quite away from the other exhibits—was the silver cup and cover designed and executed for Her Majesty the Queen. This is a beautifully proportioned work, much simpler in design than most of Messrs. Ramsden and Carr's important cups. The bowl and the shaft upon which it stands are perfectly plain, the foot is decorated with a narrow band of intertwined briar rose, and the same motive occurs again at the junction of the bowl and shaft. The cover is surrounded by a narrow cresting, and at its apex is a "noble rose," royally crowned, supported on a calix of thorn branches and smaller roses. The rose bowl designed for presentation to Sir John Furley on his eightieth birthday is much more in the artists' usual style. The smaller bowls, cups, caskets, table appointments and the like were what one has learned to expect from their makers—tasteful and distinctive, with no straining after originality at all costs. The memorial tablets were mostly small and simple; but they were well spaced, well designed and generally satisfactory in effect. Amongst the ecclesiastical work, the Crucifix and two candlesticks for a private chapel, executed in chiselled and wrought silver, stood out as the most conspicuous examples. The Christ figure was of the old clothed type, but conceived in a more modern spirit; and the candlesticks, which stood on either side of it, were massive and designed so as in some measure to repeat the vertical lines of the draped figure. The whole suggested a more satisfactory altar arrangement than some of those which have been recently shown elsewhere. The pastoral staff for the Bishop of Stafford was restrained and good in design. The churchwardens' staves for St. Margaret's, Lowestoft, and the verge for St. John's, Stamford Hill, were artistically treated versions of objects which in recent years have not had

much thought and care expended upon them, but which do offer possibilities to the designer who knows how to take them.

Toys.—From time to time through the winter there have been opportunities of seeing how the British toymaking industry was progressing. The Lord Roberts Memorial Workshops held a most successful show at Knightsbridge, and at all exhibitions of Arts and Crafts or Home Industries and the like toymakers have furnished their quota of exhibits. It was, however, the Christmas shopping season which revealed most completely the change which has come over the toy trade in the last two years; for it is from the ordinary shops that we are best able to judge of the type of toy which is really selling and finding its way to the children. Last year it was already apparent that the changed conditions were making a considerable difference in the character of the toys which were being sold. British-made toys were exhibited with labels attached to show that they were genuine home products, and a good many even of the most usual toys began to give evidence that their makers had some regard to their artistic appearance. This year, however, the change is even more marked, and it makes itself felt in all grades of toys, from the most expensive down to the penny toys sold in the streets—or, rather, down to what used to be the penny toys, for most of them nowadays cost a penny halfpenny or twopence. As a matter of fact, most of the toys sold this year for a penny were Japanese, and very pretty and dainty some of them were. Japan, indeed, has entered the market as the maker of the cheaper kinds of toys in a somewhat new guise, and is sending over not only what we used to see in the way of Japanese toys, but goods which directly take the place of toys which, before the war, used to be made in Europe. As to the English toys, there are still some spooky productions about, and some of the dolls are, to put it mildly, by no means beautiful—they remind one of a certain kind of pictorial art which does not profess to aim at beauty. Again, we suffer still from a certain number of "soft" toys, Teddy bears, rabbits and other animals which are softer than they were intended to be, and threaten to divide at awkward and unexpected points. Nevertheless, on the whole, there is an advance which is little short of wonderful, especially in the wooden toys of all sorts. It is no longer only Noah's arks that are works of art: it is no uncommon thing to find houses, villages, shops and other toys of the kind which are really things of beauty, and though some of them are expensive they are not extraordinarily dear, and they are sometimes quite moderate in price. Many of the jig-saw puzzles are from really good pictures, which do not suffer unduly from being cut up puzzle fashion, and horses and carts and a number of other toys are not only better made than they used to be in days gone by, but are planned and designed with some regard to beauty.

NOTES ON BOOKS.

ELEMENTARY QUALITATIVE ANALYSIS: A LABORATORY GUIDE. By B. Dales, University of Nebraska, and O. L. Barnebey, University of Wisconsin. New York: Wiley & Sons; London: Chapman & Hall. 1916. 5*s*. 6*d*. net.

In two important respects this book differs from the large number of first instruction books to which those who wish to learn something of qualitative testing can turn for instruction. First and foremost the wording is so exact and so unmistakable that the student can devote his whole attention to the subject-matter, instead of being driven to the verge of distraction by trying to solve verbal enigmas at a time when the attention should be exclusively incident upon the reactions, behaviour, and properties of the substance under examination. Short sentences, each complete in itself and without pronouns or expressions of uncertain meaning, are used in stating indications: thus on p. 132 we read as follows: "The residue is then ignited in platinum, and after cooling treated with HF. A platinum wire loop containing a drop of water is held in the vapors. A white cloud of silicic acid proves the presence of silicon." As a contrast, we may perhaps be allowed to quote from testing instructions given by a distinguished military officer, and published by the Royal Artillery Institution in 1896. "Now take your crystal of sapphire and try its point on your stone. If it does not scratch it and is scratched by it, the stone is a diamond beyond all doubt. If it does not scratch it, and is not scratched by it, it is a form of corundum." The second notable characteristic is a full realisation of what is likely to embarrass, mislead or endanger the student: that full realisation which only comes to the experienced teacher whose whole heart is in his work. The old concise statement that a precipitate is formed when by interchange it is possible to produce an insoluble substance, gives place to a short but lucid chapter on "The Principles of Qualitative Analysis," in which chapter there is a study of the action of mass, the intermediate colloid condition, dissociation, also such reversible actions and reactions as those in which hydrochloric acid, cadmium chloride, hydrogen sulphide, and cadmium sulphide are concerned. Among the various hints that suggest thoughtfulness on the part of the authors may be mentioned that on p. 86, as to the possible danger from acidifying a solution

containing a cyanide, the caution as to tentative experiments in relation to the possible presence of explosives (p. 122), the hint as to the silver crucible (p. 130), and the suggestion on p. 36 as to the use of library reference-books in cases of doubt or difficulty.

A Handbook for Cane-Sugar Manufacturers and their Chemists. By Guilford L. Spencer, D.Sc. Fifth Edition. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 15s. net.

The appearance of a fifth edition shows that this excellent little handbook continues to grow in popularity amongst cane-sugar manufacturers and chemists. Considerable advances in the theory and practice of the subject have been made during recent years, and in order to bring this edition up to date the book has been, to a great extent, re-written, and the chemical section has been revised to meet the conditions of the very large factories now in operation. As Chief Chemist in charge of manufacture at the Cuban-American Sugar Company, Dr. Spencer has had great experience of both the theoretical and practical sides of the work, and he writes authoritatively on the manufacture and analysis of sugar. The various processes in dealing with raw, plantation white and refined sugar are fully described, with numerous illustrations of machinery, etc., and the book concludes with a large number of reference tables which will prove extremely useful to cane-sugar manufacturers. In spite of the great amount of information which it contains, the volume is of such handy size that it can be easily carried in the pocket.

GENERAL NOTES.

Philippine Substitute for Gelatine.—A substitute for imported gelatine is made in the Philippines from a kind of seaweed brought in by the fishermen and sold in the markets. The native women use it for culinary purposes in the same way as gelatine is used in other countries, and foreigners also find it a good substitute. It is similar to the dried substance brought into the islands from Japan and China, which is extracted from various kinds of seaweed, dried and marketed in the form of bundles. It appears from a report by the correspondent at Manila of the United States Department of Commerce that the preparation of gulaman, as it is known, is not carried on in the Philippines on a commercial scale, but the dried article is imported from Japan and China, and is sold in the small shops. This commercial product is prepared by extracting the substance with boiling water, congealing the product, and then partially drying it before cutting into strips an eighth of an inch wide. The strips are then thoroughly dried for shipment. The yield is sometimes as much as 60 per cent. One part of the substance to 300 parts of water yields a jelly on cooling. The amount of raw seaweed brought in from the sea is not sufficient to meet the local demand for gelatine, but the cheapness of the imported article prevents a greater demand for the local product.

Radium Production in Bohemia.—According to a report by the United States Vice-Consul at Prague, 25,720 lb. of uraninite prepared for smelting, having an average value of about £97 per 100 lb., were produced in Bohemia in 1915, in the mining of uranium ore. Of the different uranium compounds there were produced in the Government mine in Joachimsthal 2,325 lb., of an average value of about £52 per 100 lb. The Government factory for radium compounds produced compounds containing 1·754 grammes (27·07 grains) of radium elements, having a total value of £43,036. The radium production in 1915 represented an increase of 0·879 gramme (13·57 grains) as compared with the production in 1914, the value of which shows an increase of £20,000 in round figures.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

January 24.—W. A. M. Goode, Hon. Secretary, National Committee for Relief in Belgium, "Relief Work in Belgium."

January 31.—Miss Ella C. Sykes, "The Work of the Y.M.C.A. in France."

February 7.—Robert Fortescue Fox, M.D., "The Future of British Spas."

February 14.—Lawrence Chubb, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

January 18.—Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel." The Right Hon. Viscount Bryce, O.M., D.C.L., LL.D., F.R.S., will preside.

February 13.—

March 15.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

April 19.—Surgeon-General Sir C. Pardey Lukis, K.C.S.I., K.H.S., M.D., F.R.C.S., Presi-

dent, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

MAY 17.—

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

JANUARY 18.—OCTAVIUS C. BEALE, Representative and Past President of the Australian Associated Chambers of Manufacture, "Imperial Industries after the War."

FEBRUARY 27.—ALFRED BIGLAND, M.P., "Imperial Assets and how to use them."

MARCH 27.—The HON. FREDERICK W. YOUNG, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

MAY 1.—CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

W. A. CRAIGIE, M.A., LL.D., Joint Editor of the Oxford English Dictionary, "The Lexicography of the Arts and Sciences."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

HOWARD LECTURES.

Monday afternoons, at 5 p.m.:—

WILLIAM RIPPER, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m.:—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 5, 12, 19.

JUVENILE LECTURES.

Wednesday afternoon, at 3 p.m.:—

ALAN A. CAMPBELL SWINTON, F.R.S., "Electricity and its Applications." Lecture II.

January 10.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 8...Brewing, Institute of (London Section), at the Imperial Hotel, Russell-square, W.C., 7.30 p.m. Mr. E. S. Salmon, "The Value of Hop-Breeding Experiments."

TUESDAY, JANUARY 9...Asiatic Society, 22, Albemarle-street, W., 4 p.m. Mr. H. Baynes, "The Messianic Hope and the Zoroastrian Prophecy."

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor A. Keith, "The Human Machine which all must work." (Lecture VI.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. W. Brown, "Recent Progress in Dredging Machinery."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. W. S. Barrett, "Letters and Lettering."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. O. Bloch, "Plate Speeds."

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Mr. W. Powell, "The Clarifying of British Commerce of Enemy Influence after the War."

WEDNESDAY, JANUARY 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Juvenile Lecture.) Mr. A. A. Campbell Swinton, "Electricity and its Applications." (Lecture II.)

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Colonel R. E. Crompton, "Notes on Screw Gauges."

Geological Society, Burlington House, W., 5.30 p.m. 1. Dr. C. Lapworth, "Notes on the J. A. Douglas Collection of Graptolites from Peru." 2. Mr. H. A. Baker, "On the Palæozoic Platform beneath the London Basin and Adjoining Areas, and the Disposition of the Mesozoic Strata upon it." With an Appendix by A. M. Davies.

THURSDAY, JANUARY 11...Optical Society, at King's College, Strand, W.C., 5-9.30 p.m. Exhibition of Workshop Methods of Optical Testing.

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Messrs. F. Gill and W. W. Cook, "The Principles involved in Computing the Depreciation of Plant."

Geographical Society, Burlington-gardens, W., 5.30 p.m. Mr. J. C. Besley, "The Amazon River and Unexplored South America."

FRIDAY, JANUARY 12...Malacological Society, Burlington House, W., 8 p.m. 1. Rev. Dr. A. H. Cooke, "*Patella vulgata* L. and its so-called variety *Patella depressa* Penn." 2. Dr. A. E. Boycott, "The Occurrence of Manganese in Mollusca." 3. Mr. G. C. Crick, "Note on the holotype of *Crioceratites bowerbanki* J. de C. Sowerby."

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FRIDAY, JANUARY 12, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

THURSDAY, JANUARY 18th, at 4 p.m. (Indian Section.) COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel." The RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., will preside.

[Fellows are requested to note that the hour of the meeting is 4 p.m.]

Further particulars of the Society's meetings will be found at the end of this number.

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers will be supplied, post free, for 1*s*. 6*d*. each, on application to the Secretary.

JUVENILE LECTURE.

On Wednesday afternoon, January 10th, Mr. Alan A. Campbell Swinton, F.R.S., delivered the second and concluding lecture of his course on "Electricity and its Applications."

The lecturer began by showing some striking experiments with a Tesla coil, and its remarkable effects on a fluorescent screen. He also demonstrated how the current could be discharged from the operator to another person, or to other objects, and in this way he set fire to gunpowder and alcohol from his finger-tips. He then passed on to describe the carbon arc light, and projected on the screen an image showing the poles at a temperature of about 6,000° F., or half that of the sun.

The various kinds of searchlights and their mirrors were next dealt with and their mechanism explained. A new lamp for use in lantern projection (known as the "Point-o-Light") was shown, in which a globule of tungsten is raised to white heat in nitrogen, giving an intense light from a very small point. A mercury arc lamp was also exhibited, and attention was drawn to the way in which, owing to the small amount of red in the light from the lamp, red objects appeared black and human beings became corpse-like in colour.

It is not generally known that glass, and other insulating materials, at very high temperatures, become conductors of electricity; but the lecturer demonstrated this fact by passing a powerful electric current through two pieces of glass which had previously been raised to a white heat.

A pretty experiment was performed to show how a very small quantity of heat applied to a thermopile made of two metals (antimony and bismuth) connected together alternately, is sufficient to generate an electric current. The heat of the finger, when brought in contact with the instrument produced a marked disturbance of the galvanometer.

Mr. Campbell Swinton then proceeded to describe the selenium cell and its uses, the electric bell, the magneto bell, and the telegraph. When speaking of the Morse code, he showed an American instrument, known as the "practice buzzer," which automatically gives out messages in Morse, which the student attempts to write down as they are delivered.

In speaking of the telephone, the lecturer showed some remarkable photographs, taken by Mr. W. Duddell, F.R.S., of sound waves caused by speech, in which the vibrations varied from 40 to 40,000 per second. He then explained the action of the diaphragms in the transmitter and receiver of the telephone. The delicacy of a good instrument, he said, was such that an ordinary person could hear when the current was as small as one-billionth of a watt.

In conclusion, Mr. Campbell Swinton threw on the screen a number of photographs illustrating the action of the turbine, and also showing some of the great turbines themselves which are now used at Lots Road and elsewhere for generating enormous quantities of electricity.

On the motion of the Chairman, the Hon. Richard Clere Parsons, a cordial vote of thanks was accorded to Mr. Campbell Swinton for his very interesting course.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

COAL AND ITS ECONOMIC UTILISATION.

By John S. S. Brame,
Professor of Chemistry, Royal Naval College, Greenwich.

Lecture II.—Delivered December 4th, 1916.

The need for research work in the composition of our various coals is patent when we consider how limited our knowledge of the subject really is, and how helpful it would be to the better utilisation of coals, especially the inferior varieties, if more definite knowledge were available of their constitution.

In the series of Cantor Lectures given by the late Professor Vivian B. Lewes in 1911 on the "Carbonisation of Coal," he dealt at some length on our knowledge up to that date of the nature of coal. With his usual clearness, he traced the various steps which had led to the conclusion that the different classes of coal were the result of the presence of varying proportions of decomposition products arising principally from cellulosic bodies (lignin, etc.), on the one hand, and the resinous constituents, gums, etc., on the other hand, of the original vegetation.

Burgess and Wheeler (*Chem. Soc. Trans.* 1911, 99. 653) had stated early in the year their opinion that "one type of compound in coal, and the most important type, is a degradation product of cellulose"—"the resins and gums originally contained in the sap of the coal plants form the cement of a conglomerate, of which the cellulose derivatives are the base."

Following an old nomenclature, Lewes termed the degradation products of cellulose "humus bodies," having the following approximate composition: Carbon, 63 per cent.; hydrogen, 5 per cent.; oxygen, 32 per cent., whilst the resinous residues had the approximate composition: carbon, 79 per cent.; hydrogen, 11 per cent.; oxygen, 10 per cent.

The resinous derivatives were regarded as the binding or cementing material, and the constituents which determined the formation of a coherent coke when coking coals are carbonised.

At a sufficiently high temperature they gave rise to distillation products which condensed in the shales of the coal measures, and, to some extent in the coal itself, as hydrocarbons.

He stated his opinion that these resinous bodies were of two kinds—one, easily oxidisable, saponified by alkalies and soluble in pyridine; the other not easily oxidisable (probably because oxidation had already proceeded nearly to completion) and forming an insoluble compound with pyridine.

If a coal had been subjected to high temperatures under pressure very little of the resinous matter preserved its original character sufficiently for identification.

Lewes regarded the different varieties of coal, then, as consisting principally of varying proportions of the humus constituents derived from cellulose, luted together by resins or resinous derivatives; and possibly also some hydrocarbons and carbonaceous residues, closely approaching to carbon itself. On distillation he believed that the humus bodies begin to distil about 300° C., giving off principally hydrogen, methane and the oxides of carbon; the resin bodies begin to distil at about the same temperature, the products consisting principally of saturated and unsaturated hydrocarbons and cyclic hydrocarbons (naphthenes). In his own mind, no doubt was left that the resin bodies and hydrocarbons were the cause of the "binding" when certain coals are coked, these bodies undergoing destructive distillation, leaving a pitch which acted as a cement.

Before proceeding to review briefly subsequent work, reference may be made to some old results of considerable interest which Smythe published on the results of extracting lignites with benzene and chloroform. The benzene extract (3 per cent.) was reprecipitated with petroleum ether and then the precipitate extracted with ethyl ether (*a*). The part insoluble in ether was extracted with acetone (*b*), leaving the insoluble part (*c*). Also by chloroform a body was extracted (1·8 per cent.) (*d*). The composition of these extracted substances is given below, and agrees with the composition of resins which have been found in masses in lignites:—

	From benzene.			Chloroform.
	a.	*b.*	*c.*	*d.*
Carbon .	77·2	79·23	77·75	76·45
Hydrogen .	8·26	12·83	11·77	9·91
Oxygen .	14·54	7·94	10·48	13·64
Melting-point	135°–140°C.	78–80°C.	80–83°C.	94°C.

Turning now to more recent work on the chemical side of the question, Bergius and Billwiller (*Jour. Soc. Chem. Ind.* 1913, 466) showed that by heating peat at a temperature of 340° C. in an apparatus constructed to withstand very high pressures—so high that water remained liquid—a black powder was obtained which, at

this same temperature and under very high pressure, underwent further change and resulted in the formation of an artificial coal. Unfortunately no analysis is given of the final product, but the results certainly indicate the general character of the changes through which cellulose probably passed in the formation of coal.

Several papers have also been published by Wheeler and his co-workers at the Government Laboratory of the Explosions in Mines Committee at Eskmeals. Burgess and Wheeler (*Chem. Soc. Trans.* 1911, 99. 649) had tentatively put forward the view that when coal is treated with pyridine, the insoluble portion was derived from cellulose, and that possibly the soluble portion represented the resinic constituents, although there was some reason against a definite conclusion on this point. Clark and Wheeler (*Chem. Soc. Trans.* 1913, 103. 1704) record the results of further experiments and show that part only of the pyridine extract is soluble in chloroform, and that the insoluble portion is of much the same character as the part originally left undissolved by the pyridine, so that this solvent is not without action on the "humus bodies."

They concluded that the treatment of coal, first with pyridine, and the subsequent treatment of the pyridine extract with chloroform, effect a complete—or nearly complete—separation between the resinous constituents and the degradation products of the celluloses.

In conjunction with C. B. Platt, a very pretty confirmation of these results was obtained by adopting a method discovered by W. J. Russell (*Proc. Roy. Soc.* 1908, B 80. 376) of testing the action on a photographic plate of resins and coals. When such substances are placed in contact with the film and maintained at 50° C. for some hours, on development an image results. Wheeler and Platt showed that whilst the portion of their coal which was insoluble in pyridine, and the portion soluble in pyridine but insoluble in chloroform, had no action on a plate, the portion of the latter which was soluble in chloroform (resin constituents) had a very strong action.

Pictet and Bouvier (*Compt. rend.* 1913, 157. 779) published results for the distillation of some 30 kilos of Montrambert (Loire) coal at a temperature of 450° C. and pressure of 15–17 mm. mercury. Four per cent. of tar, free from phenols, was obtained. After the considerable quantity of secondary bases which was present had been removed, on fractionating the remainder the first distillates resembled petroleum distillates; the later fractions had the odour of terpenes and menthol.

When this tar was distilled through an iron tube packed with coke heated to dull redness, a gas similar to ordinary illuminating gas, and a tar similar to ordinary tar were obtained. Pictet and Bouvier concluded that the greater part of the hydrogen and methane of the gas, and of the aromatic hydrocarbons and phenols of ordinary tar, are secondary products of the hydro-aromatic and other hydrocarbons formed at low temperatures.

Mr. Mclaurin, working on low-temperature carbonisation by a process in which the coal is heated by passing water gas directly from a producer through the coal, the temperature being about 400° C., appears to have obtained a very similar tar to that of Pictet and Bouvier; it was entirely soluble in sodium hydroxide; it contained practically no benzene or toluene, but about 6 per cent. of cresylic acids.

Jones and Wheeler were working at the time on similar lines to Pictet, and published their results a little later (*Chem. Soc. Trans.* 1914, 105. 140). Their results differed in one important respect, namely, that phenols (cresols and xylenols) were found in the tar. The temperature employed was 430° C., and it was pointed out that "at low temperatures coal in its entirety cannot be expected to reveal the nature of all the various classes of components which go to form the coal substance," because "only the resinic substances decompose to any great extent below 500° C.," so that "it is the resinous substances only, therefore, that must be regarded as having undergone examination by the method of attack described."

From the examination of the tar oil they concluded that it contained (1) unsaturated (ethylenic) hydrocarbons (40–45 per cent.); (2) naphthenes and liquid paraffins (40 per cent.); (3) phenols, chiefly cresols and xylenols (12-15 per cent.); (4) aromatic compounds, apparently homologues of naphthalene (7 per cent.), and other minor constituents.

Here we have the presence of phenols which Pictet and Bouvier did not obtain. This may have arisen from the totally different character of the coals used, or from the use of an upright retort by the French chemists, so that tarry products may have condensed and returned to the heated zone, whilst at Eskmeals the retort was inverted, the products escaping below.

A further contribution on the subject was published by Jones and Wheeler (*Chem. Soc. Trans.* 1914, 105. 2562) dealing with the products

obtained *in vacuo* at 350° C., which generally confirmed the results at higher temperatures, phenols being present again.

Summarised, then, as they were later (*loc. cit.* 1916, 109. 707), the Eskmeals results confirm the presence of the degradation products of cellulose, as the main constituent of bituminous coal, and of resinic derivatives. They claim that the former yield liquid distillates in small amounts and consisting largely of phenols. The resinic constituents, on the other hand, lose half their weight at 450° C., the liquid distillates consisting of "all the components of tar obtained by the low-temperature carbonisation of coal, with the exception of the phenols which are absent."

Although, then, the phenols are claimed to be formed only from the cellulosic bodies, and that only the resinic bodies are claimed to have undergone examination by this method of low-temperature distillation, yet *phenols are present to the extent of* 12 to 15 *per cent.*, and to the extent of 17 per cent. in the tar from a Durham coal (*loc. cit.* 1914, 2564). If the phenols are not formed from the resinic components and the cellulosic degradation products do not undergo appreciable decomposition, as claimed, from what source have they been derived?

It is well known that low-temperature tars are characterised by a high content of phenols (cresols and xylenols). Attention might again be directed to the absence of phenols in Pictet and Bouvier's work, and this is more in accordance with the claims of Wheeler and his colleagues than the results they obtained themselves.

Criticism may be directed against the use of pyridine, although, so far, it has proved the most useful solvent in the extraction of coal. Lewes pointed out the overwhelming evidence that pyridine had entered into combination with both the insoluble and soluble portions in nearly every record of work which had been published. Harger (*Jour. Soc. Chem. Ind.* 1914, 33. 389) records experiments he had made, and directs attention to the Eskmeals results. From Clark and Wheeler's data on Silkstone coal he shows that it is evident that all the fractions contained more nitrogen, in total, than the original coal, and calculates that pyridine amounting to 4 per cent. on the coal was retained; further, that considerable oxidation had occurred in both the pyridine and chloroform extracts, the oxygen in the latter being increased to 60 per cent. A further important point noted by Harger was that the chloroform soluble portion did not appear to be present in the original coal, as such. He concludes that with pyridine there is "some kind of simplification which yields the pyridine soluble matter, a process similar to depolymerisation and due to the action of pyridine and heat."

In the main these actions probably have not affected the general conclusions of Wheeler and his associates, but one would have expected Harger's criticisms to have been referred to in subsequent papers by Jones and Wheeler.

These authors have put forward various speculations as to the chemical structure of the types of compounds likely to be present in coal which gives rise to the various products on low-temperature distillation; but until the difficulty of accounting for phenol, above referred to, and until the "resinic" bodies have been obtained free from combined pyridine, or by the use of other solvents obtained in a more pure condition, such speculations would appear premature.

In general, however, the following conclusions would appear fully justified. In the first place, it is concluded that the free carbon, usually assumed to be present in coal, is improbable—on the grounds that any bacteriological changes would be unlikely to produce it, and that the temperature to which the coal during, or subsequent to, formation has not been subjected to temperatures high enough to result in such complete carbonisation. Further, the pressure would be against such complete carbonisation. (In many coals there is often a considerable amount of "mineral charcoal," the dant or "mother of coal," which in all probability does contain free carbon.)

The cellulosic derivatives are regarded by Jones and Wheeler as probably few in type, whilst the resinic derivatives are very complex. Several hydrocarbons have been obtained from coal by them and other workers.

An extensive investigation of coal, using phenol as a solvent, was carried out by Frazer and Hoffman in the United States Bureau of Mines laboratories (Tech. paper 5, 1912). On the basis of the pure coal substance phenol dissolved 10·9 per cent. The phenol extract was further treated with a great variety of solvents and the products analysed. The authors concluded that some nearly pure compounds had been isolated, but the amounts obtained were so small that this could not be definitely established. Some, however, appeared to be almost pure hydrocarbons, containing small quantities of oxygenated compounds. Amongst the highly-

oxygenated compounds was one agreeing closely with the formula $x(C_5H_7O_2)$:—

	C.	H.	O.
Product	60·0	7·06	32·94
Formula $C_5H_7O_2$ . .	60·6	7·07	32·40

Parr and Hadley, by extracting with phenol at 110° C. for twenty hours, found that all the coking constituents and the greater part of the volatile matter were removed from the coal; they make also one very significant observation—that the elementary composition of the coal, the extract, and the insoluble residue were practically the same, and this applied also to the gaseous products of decomposition of each.

More recently F. Fischer has employed liquid sulphur dioxide and has extracted typical resins from lignites. This solvent may well prove of considerable service in the chemical examination of coal, being probably preferable to most of the organic solvents employed. It has proved of considerable value in the examination of petroleum, and has already been employed on a commercial scale for refining of petroleum distillates.

From the above *résumé* the need for extended research is evident, and this will no doubt be vigorously prosecuted under the grant recently announced for the investigation of our coals. Probably the application of methods which have thrown so much light on the composition of alloys, the examination of microstructures developed by solvents, together with the chemical examination of the extracted bodies from larger masses of the coal, will prove a fruitful line of attack.

Turning to the application of coal in practice, so numerous are the purposes for which it is employed and so varied the methods of employment, that only a brief reference will be made to the more important uses, particularly with a view to pointing out how the more economical use may be attained.

Taking first into consideration the use of raw coal in metallurgical and other furnaces, the long hot flame from bituminous coal is usually required, but the conditions of combustion are such that, in general, very inefficient use is made of the coal. In the first place, the efficiency of heating furnaces is usually very low: with reverberatory furnaces under the best conditions it is probably about 15–17 per cent.; over 75 per cent. of the heat units are lost in the flue gases. The flaming tops to the chimneys of large numbers of heating furnaces are evidence of the big heat losses. The application of the regenerative system, so successful with gaseous fuels, is very difficult with solid fuels. Moreover, such furnaces are very bad smoke producers. Whenever a mass of material is being heated up by luminous flames, the great difference in temperature leads to chilling and the formation of smoke.

In the use of raw coal for steam-raising, it must be recognised that some coals give such excellent results in practice that they have acquired a relatively high market value. For hand-firing a good-sized coal is requisite, and a great deal depends on the skill of the fireman. Suitable coals have consequently been worked out for this purpose, to the neglect of somewhat inferior coals, or the same coal in a broken condition.

The introduction of mechanical stokers has been a considerable factor in economy, in two directions: first, in permitting of the use of small "slack" coal, which was unsuitable for hand-firing; secondly, in facilitating more regular and complete combustion, with large reduction in smoke, because of the principle of regular feeding of the furnace, so avoiding rushes of unconsumed gases, and further by allowing better adjustment of the air supply, which contributes greatly to the efficiency of the boiler.

However good the boiler practice may be, there are inevitable losses which reduce the efficiency to possibly some 70 per cent. Heat is lost in the flue gases, this being the principal loss. The flue gases must escape hot with "natural" draught to give the necessary air supply. Reduction of these losses is effected by the use of economisers, where heat is made use of in warming up the feed-water. Then other inevitable losses occur with the hot ashes, and, to a certain extent, with incomplete combustion. On the other hand, very low efficiencies are common through avoidable causes. Large excess of air through the furnace carrying away an excessive proportion of the heat is one of the most common. Again, there may be incomplete combustion, in most cases evidenced by smoke, although it may exist without visible evidence, carbon monoxide being formed instead of carbon dioxide, when approximately two-thirds of the heat it is possible to produce per unit weight of carbon is lost for every unit so consumed.

The scientific control of the combustion process is a great factor in fuel economy. By the analysis of the flue gases the engineer in charge can ascertain if any unnecessary excess of air is passing through the furnace, or i

combustion is incomplete. The percentage of carbon dioxide in the flue gases is usually a sufficiently good guide as to excess air, and fortunately this is a very easy gas to estimate. Automatic carbon dioxide recorders are now frequently installed, and result in very considerable economy in fuel.

Pulverised coal offers considerable promise as an efficient boiler fuel; probably in this form it can be used more efficiently than in any other form. Rotary cement kilns are commonly fired with coal dust carried into the furnace by an air blast; a long fierce flame rivalling that with oil fuel is obtained, and this is quite free from smoking propensities. Trouble is sometimes experienced through the dust from the ash; sometimes it even fuses on the surface of hot pipes and plates. It would appear that the cost of drying and pulverising the coal is about 1*s.* 6*d.* per ton. It is doubtful whether the system offers any advantages over a good mechanical stoking plant, when the whole of the factors are taken into account.

Another method of utilising small coal as fuel is that of briquetting, large quantities of the small steam coal being disposed of in this way in South Wales. It is notably on the Continent that briquetted coal has been most extensively adopted, and at one time this industry formed a profitable outlet for the surplus pitch from English gasworks. In this country the industry is confined chiefly to the South Wales coalfield, which produced, in 1914, 1,599,713 tons of briquettes out of a total British production of 1,840,465 tons. Ninety-six per cent. of the coal briquetted was small Welsh steam coal.

In briquetting the coarsely-ground coal is dried, mixed with from 6·5 to 8 per cent. of its weight of pitch, passed through a disintegrator, thence to a heater to soften the binder and on to the briquetting machine. One advantage of briquettes is their regularity of shape, which gives to briquetted fuel a high stowage value—an important consideration in shipment.

The use of "prepared" fuels from coal is very extensive. These may be classified as: Solid fuel, coke; liquid fuels, benzol and tar oils; gaseous fuels, coal and coke-oven gas, producer gases.

No more than a reference is necessary here to the general use of hard metallurgical coke for blast furnaces and other metallurgical purposes, but more specific consideration may well be given to ordinary gasworks coke, which is a by-product, for industrial use. The subject is of considerable economic importance, because its production is accompanied by the recovery of the other valuable tar products and by the gas; further, it provides an outlet for the surplus coke from gasworks, of which several million tons are produced annually.

The yield of coke in ordinary gasworks practice is about 65 per cent. of the coal carbonised. On the total carbonised annually this will amount to some 11 million tons, and although about 15 per cent. will be required to carry out the carbonisation, and probably 1½ million tons is converted into water gas for admixture with the coal gas, there is a large surplus to find economical outlets for.

Considerable attention has been given to its use for steam-raising. Owing to the almost entire absence of volatile constituents coke is difficult to ignite and requires a strong draught, so that forced or induced draught has to be installed. The London Coke Sales Committee has developed a special grate for the use of coke. The conditions of combustion are different from those with coal, because there is very little gas to burn, except perhaps a flame of carbon monoxide, the whole of the fuel being practically consumed on the grate. Less excess air is consequently required for combustion, thus reducing heat losses in the flue gases. An advantage is the absolutely smokeless combustion. Because of its porous nature the stores and bunkers hold a smaller number of potential heat units than with coal, and the ash is, of course, higher than with coal, averaging about 1·4 times the coal ash. This may lead to clinkering, since the fuel is all burnt on the grate under good draught, so that high calorific intensity is obtained.

It has been claimed that the sulphur in coke is detrimental, but it is difficult to see why this should be, for during the production much of the original sulphur escapes in the gas and tar, coke containing usually about 70 per cent. of the sulphur originally present in the coal.

Very successful results have been obtained with coke for steam-raising. At Deptford, over a period of one month, 16 per cent. was saved in fuel costs. Steam-driven lorries are working on coke, as are also colliers belonging to some London gas companies and steam tugs. With the present high prices of coal and difficulties of delivery, many power-station engineers are either already employing coke or putting in hand the necessary alterations for its adoption.

With water-tube boilers, the probable development will be on the lines of an internal producer,

primary air being used to gasify the coke in an arched chamber, through openings in which the gases will pass, then mixing with the secondary air to complete combustion. In this way smokeless flames would result and the brick arch would form an efficient radiating surface. The drawback would be that extensive alterations would be requisite if coal had to be burnt.

Another development in the use of coke of quite recent date is the briquetting of the small waste which accumulates at gasworks, and is of little value. This method is of considerable importance at present because, with the large production of tar and the closing of the Continent to the shipments of pitch, this material is accumulating at most works, and the use of a portion to assist in converting the unmarketable coke into a fuel of the selling value of 12*s*. 6*d*. per ton is a double economy.

A plant installed at Smethwick Gas Works over a year ago has proved very satisfactory. Through the kindness of Mr. Vincent Hughes I am able to exhibit samples of these briquettes.

In manufacture the coke dust is graded to pass a ¼-in. mesh sieve, and is mixed with 8 per cent. of pitch, this mixture being fed to the disintegrator. In the heater a little tar is added, and the hot mass briquetted at 6 tons pressure. A full description of the plant will be found in the issue of the *Gas World*, November 11th, 1916. At Smethwick the plant relieves the works of about one-sixth of the pitch made. If the coke breeze were also briquetted, one-third of the pitch could be utilised.

The briquettes are suitable for closed stoves, ranges, etc., and form the only boiler fuel used at the works. For the usual open grate the draught is insufficient to burn them without a proportion of ordinary coal.

Similar plants for briquetting, but of greater capacity, are being installed at Coventry and Northampton.

The other "prepared" fuels from coal are the tar and tar products, and the gaseous fuels, coal or coke-oven gas and producer gas. It will be convenient to leave the consideration of the gaseous fuels for the present, and deal with the composition and important products derived from tar.

The use of tar (or tar products) as fuel will depend entirely upon the quantity produced, and the market for the valuable raw materials it yields. At present all tar yields more valuable returns after distillation, and the demand for many of its products for munitions is so great that it is a national necessity to utilise all available tar in this way. On the other hand, within quite recent years the price of tar was so low that an outlet for fuel purposes, for road work, etc., was found.

The economic use of coal is closely associated with the question of the by-products—ammonium compounds and the tar—many important chemical industries being dependent on the latter, whilst the small quantity of nitrogen in coal—averaging about 1·4 per cent.—furnishes our principal supplies of ammonia compounds. The sulphate of ammonia alone is a most important material as a fertiliser, and its importance to agriculture can hardly

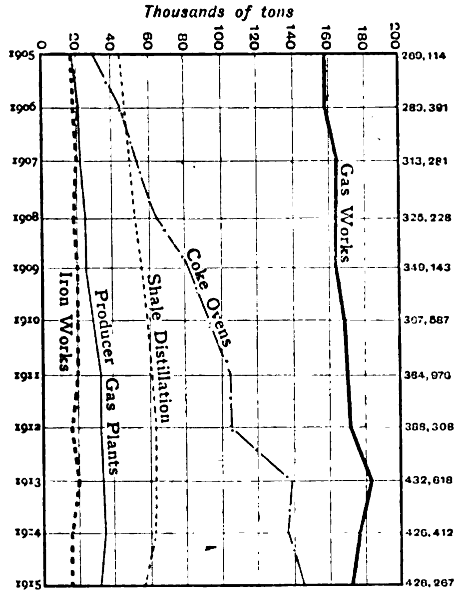


FIG. 3.—PRODUCTION OF AMMONIUM SULPHATE.

be overestimated. In the increased production of home-grown foodstuffs, generally admitted to be a pressing question, it must undoubtedly prove an important factor. It is one of the romances of science that by means of sulphate of ammonia we are actually returning to plant life nitrogen derived from a previous vegetation which flourished millions of years ago.

The total output of this salt in 1913 was 432,618 tons. Under the best conditions of carbonisation not more than the equivalent of 20 per cent. of the nitrogen is obtained as sulphate; about 70 per cent. remains in the coke, and can be mostly recovered when the coke is gasified in a producer. When bituminous coal is gasified in producers a high yield of ammonium sulphate is 90 lb. per ton, which equals a conversion of about 68 per cent. of the nitrogen into sulphate.

The great increase in the production of ammonium sulphate in recent years will be seen from Fig. 3 (p. 155), which shows the total annual production, and the yield from gasworks, coke ovens, blast furnaces and ironworks. The effect of the introduction of recovery plant in coke-oven practice is very marked.

Besides the sulphate, the ammoniacal liquor of the gasworks may be worked for strong ammonia which is liquefied for use in refrigerating machines, for strong ammonia solution, or for other salts, such as the chloride or nitrate, the latter forming the main ingredient of an important class of explosives, used for both mining and military purposes.

Other valuable nitrogen compounds now extracted from the distillation products of coal are cyanides, which find application in the extraction of gold.

The yield of first products from 100 tons of coal is shown below:—

Benzene, the most important of the hydrocarbons obtained from the tar, has proved a valuable fuel for motor engines. In addition to that derived from the tar, further quantities may be obtained by washing the gas with heavy oils which dissolve the benzene and yield it up again on distillation. Ordinary coal gas scrubbed in this way has its illuminating and calorific value reduced very materially, and it is not possible to carry this oil scrubbing to the point of complete removal of the benzene without detracting too much from the value of the gas. Coke-oven gas can, however, be stripped of benzene.

The importance of benzene as a fuel in lieu of petrol is very great; ample supplies of such a home product would do much to check artificial prices for petrol. It has been estimated that it would be possible to produce annually some twelve million gallons from gasworks and sixty million gallons from coke ovens, if all coal were treated in recovery plant.

100 TONS BITUMINOUS COAL.

Coke.	Sulphate of Ammonia.	Cyanide of Sodium.	Gas Tar.	Coal Gas.
65 tons.	$1\frac{1}{4}$ tons.	2 cwt.	975 gallons (5 tons).	1,100,000-1,200,000 c. ft.
Metallurgy. Heating.	Agriculture. Explosives. Soda manufacturing. Refrigeration.	Extraction of gold, etc.	Motor fuel. Explosives. Dyes. Drugs.	Light. Power. Heating.

The tar is the most important of the by-products obtained, and certainly no substance has yielded so many valuable products for the service of man. It must be clearly realised that the tar contains but few bodies which are utilised directly after separation, the principal being benzol, solvent naphtha, carbolic acid and its cousins, the cresylic acids. All the vast number of beautiful dyes, of valuable drugs, disinfectants, flavouring essences and perfumes, and photographic developers are the outcome of the work of the chemist on the raw materials furnished by the tar.

In the first place the tar is distilled and portions collected at various temperatures, so yielding a number of fractions, which by further treatment yield ultimately pure products. The general scheme of fractionation and the principal products from each fraction are shown below:—

Benzene is also employed for cleaning purposes (cloth, fabrics, etc.), and quantities are now converted to synthetic phenol (carbolic acid), from which picric acid (Lyddite) is prepared.

Another hydrocarbon closely allied to benzene is toluene, for which there is a great present demand for conversion into trinitrotoluene (T.N.T.), the powerful high explosive. Quantities are now obtained by oil scrubbing of the gas and also synthetically from benzene.

Phenol (carbolic acid) can be extracted directly from the light oil and carbolic oils by washing with caustic soda; also the closely-allied cresylic acids. All yield high explosives on nitration.

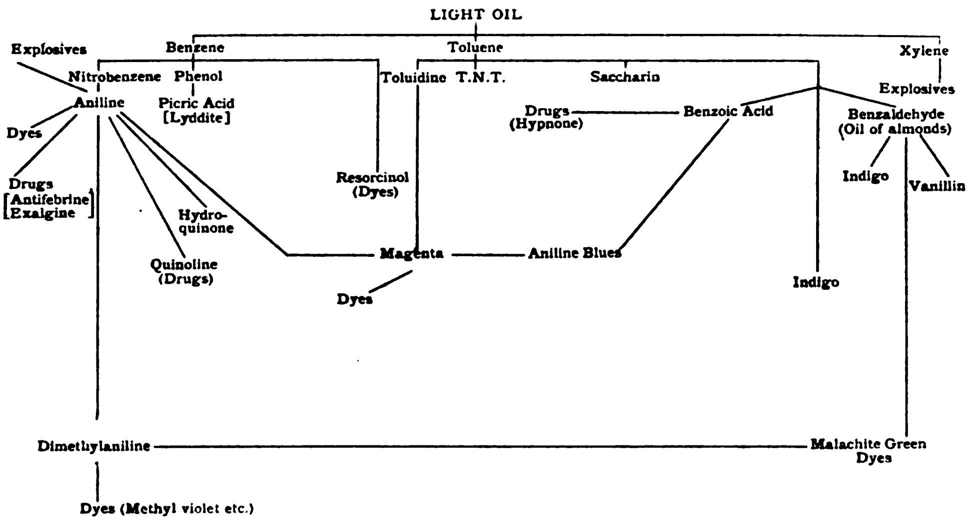
The importance of tar products for furnishing munitions of war is very great. The necessity

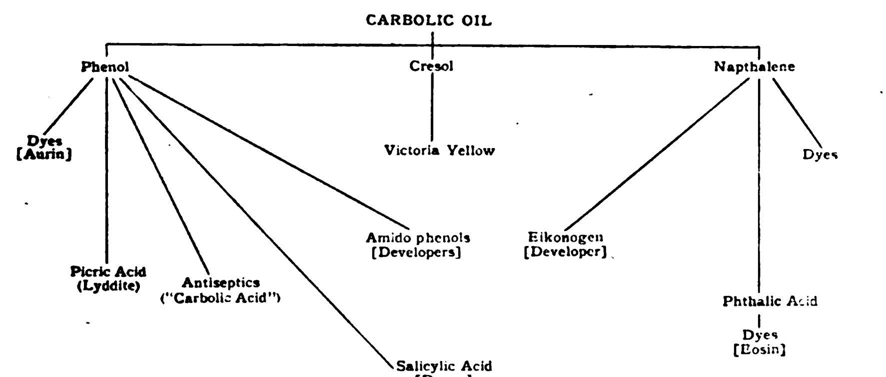
CRUDE TAR.

Light oil (to 210°)	Carbolic oil (210°–240°)	Creosote oil (240°–275°)	Anthracene oil 275°–320°)	Pitch.
↓	↓	↓	↓	↓
Benzene 1 per cent. Toluene 6 per cent. Xylenes.	Phenol 2 per cent. (Carbolic acid). Cresol.	Used for preserving timber.	Alizarin colours.	Briquettes (with coal or coke).

for increasing our output of the principal raw materials was soon evident, and the manner in which the managers of gasworks and coke-oven plants have responded to the demands has been wonderful.

It is impossible here even to outline the chemistry of the processes by which the raw materials furnished by the tar distiller are converted into dyes, drugs and other valuable derivatives. The general relationship of some of the principal of these to the original material is shown in the following diagrams:—





ENGINEERING NOTES.

Cable Telegraphy.—A new invention, devised by Mr. J. B. Dixon, has been in practical operation on certain of the Atlantic cables, and is reported to have given remarkable results, the speed of operation in the commercial handling of cable messages having been increased upwards of 125 per cent., while in tests far greater speeds have been attained. The gain in speed is due to the use of selenium cells to amplify the signals received, and to the use of means for obtaining, from one or more sources of illumination, a very large number of light beams, concentrated coincidently upon selenium cells, and deflected by a line galvanometer across the surface of the cells, the effect being that a very intense illumination of the cells is obtained. It is found that the practicable speed of operation increases as the intensity of illumination increases. The selenium cells operate a siphon recorder or a relay. There being no physical connection between the recorder or relay and the line galvanometer, the inertia and frictional losses present in the older magnifying and recording apparatus are largely eliminated, the more so as in the new system the amplitude of vibration of the galvanometer coil

is, in general, much less than in the case of the older apparatus. It is stated that Mr. Dixon employed forty-five separate light beams, all derived from one 400 candle-power tungsten lamp, and all concentrated on a thin galvanometer mirror 5 in. long and ⅜ in. wide. These light beams were reflected from the galvanometer mirror, in one case, a distance of 7 ft. 6 in., and were then re-reflected a further distance of 7 ft. 6 in. to the selenium cells, the light beams being concentrated coincidently upon the cells. With this apparatus, working over one of the trans-Atlantic cables, the normal rate of operation of which is less than two hundred letters per minute, a speed of 450 letters per minute and higher was obtained in the regular commercial handling of business, and still higher speeds have been obtained on tests, with signals fully readable as to size and character.

Coal in Spitzbergen.—The Norwegians are showing much enterprise at present in the matter of establishing coal-mining in Spitzbergen, and the prospects appear to be encouraging. The nearest markets for the Spitzbergen coal are Northern Norway, Kola, Archangel, Iceland (where, however, coal is also being mined), and the Faroe Islands. The *Times*, in its Engineering Supplement, states that the Norwegian Spitzbergen Syndicate will have shipped some 20,000 tons of coal to Norway before navigation closes for this year, and extensive preparations are being made for the future, especially as regards the welfare of the men. For about 1*s*. 9*d*. a day the men get good board and lodging, light and heat, and they all seem anxious to stay over the winter. The Norwegian Coal Fields, Spitzbergen, another recently formed undertaking, has acquired the deposits of the Spitzbergen Coal and Trading Company. The area is of considerable extent, and has been carefully examined. The deposits are calculated to contain 500,000,000 tons of coal, the quality of which has been thoroughly tested in practical use in Norway. The production is expected to reach 70,000 tons during the second year of working, and when the plant has been extended an annual production of 150,000 tons is expected. An expedition, sent from Norway during the summer, to examine the area held at Green Harbour and Advent Bay by the Svalbord Coal Mining Company, discovered some deposits not previously known. A portion of the same seam had indeed been found in the Hiorth coalfields on the east side of Advent Bay, but was supposed to form part of a seam already known. It now, however, appears to be an independent deposit, having a great horizontal extension in the area of the Svalbord Company south-east of Advent Bay. That company's coalfields at Advent Bay are calculated to contain 680,000,000 tons of coal, taking into account the ten seams likely to prove worth working. At Green Harbour, the coalfields are estimated to contain 200,000,000 tons. Working plans are to be completed this winter on the basis of an annual output of 200,000 tons, and the erection of plant will be proceeded with next summer.

Novel Method of Erection adopted in Roadway Bridge Span in America.—Exceptionally daring and successful for work of such magnitude was the method of erecting the trusses for the 592 ft. three-hinged arch roadway bridge crossing the Colorado River at Topock, Arizona. This span ranks third among arch bridges in that country, and is the longest roadway bridge of its kind. The bridge is located near the Red Rock cantilever bridge of the Santa Fé Railway, crossing the Colorado River on the route of the national "Old Trails" highway. The river at this point is very swift. During construction of this bridge last winter it often ran from fifteen to eighteen miles per hour. The river bed is a fine silt, very changeable, the depth of this silt being from 80 to 100 ft. at the bridge site. The main stream is under the California half of the arch span. A rise of 1 ft. would often result in scouring out 25 ft. of the silt, and after the completion of the bridge a rise of 4 ft. took out all the falsework except the piling under the centre tower. The total length of the steel superstructure is 832 ft., including the main 592 ft. arch of thirty-two panels at 18 ft. 6 in. each, with a rise of 100 ft., and approaches at each end consisting of two 56 ft. plate girder spans carried on steel bents and towers. The main arch trusses are 25 ft. centre to centre, while the approach girders are 22 ft. on centres. The floor system consists of rolled beams, supporting a timber floor for a 17-ft. clear roadway, suspended from the middle arch and supported by each abutment end. The extremely treacherous conditions of the river bed at the site, as described, made the usual method of erection by the use of high falsework not only very expensive, but also dangerous. As will be seen by the description given below, it was possible to erect the trusses in a nearly horizontal position with the use of very little temporary falsework. The trusses on the Arizona side were supported by several posts resting upon the sand. The California trusses on the other side of the river were supported upon pile bents, with the piles driven about 25 ft. into the silt of the river bottom. These pile bents on the California side made a working floor for the erection derrick, and on this floor pony bents carried the steelwork. The piling was driven by a stiff-leg derrick, on which the extreme length of boom used was 120 ft. The scheme of erection thus adopted, which worked out with great economy and with complete satisfaction, included the construction of a temporary steel tower upon piling at the centre

of the span, using floor steel for the columns and bracing and hoisting apparatus with which the half spans could be revolved vertically into place around the end pins by raising them at the centre. It was planned to avoid danger from a sudden washout of the falsework, under the California trusses, by supporting the trusses on the centre tower and on the lower pin. The main abutments were first constructed, the end hinges set in place, and the trusses on the Arizona side built out on the sand bar from that side and continued to the centre hinge. Piling was then driven into the river from the centre tower to within approximately 60 ft. of the California end hinges. The California end hinges were next set, and erection of trusses then proceeded toward the centre tower, cantilevering across the 60-ft. gap by shore supports. Thus, should the falsework fail, the erected portion of the California trusses could be held by the central tower and the lower end hinges. All joints in the main trusses were riveted up. Lateral struts and lateral diagonal rods were bolted loosely in position so as to allow some slight movement between the trusses during erection. Sufficient lateral bracing near the centre hinge was left out to allow both half spans, when lying in the horizontal position, to pass the erection tower, which was made just wide enough for sufficient clearance. In the abridged article by the *Engineering Record* of New York, the details of the temporary tower are fully described. Two 30 h.p. engines located on the Arizona shore were used to raise the half spans after they had been riveted up complete except for the lateral bracing, with end pins in position. Using a ⅞-in. cable and a 9-sheave upper block with an 8-sheave lower block, the California half span was raised first, the actual working time being about 15 minutes, and the total time 40 minutes. These trusses were raised about 3 ft. higher than their final position in order to allow the Arizona trusses to pass. This gave about 6 in. clearance. The sheaves were transferred to the other corners of the tower, and the Arizona trusses raised in a total time of about 30 minutes, and the same actual working time as the California trusses. About six hours were then required to lower the two sides together until the crown hinge came to a bearing. The auxiliary half hinges were then riveted up. So accurate was the shopwork that the final position of this crown joint when connected up was within ½ in. vertically and ⅜ in. laterally of the true position, allowance being made for temperature variations. The centre hinge of the ball-and-socket type is of cast steel, with a spherical compression bearing. The milled head of convex bearing surface fits the concave spherical surface of a nickel-steel compression piece carried by the cast-steel hood attached to the other truss. For adjustment, steel shims of varying thickness could be inserted in the pan of the hood back of the nickel-steel compression piece. For the purpose of tying the trusses together at the hinge and resisting any possible tensile stress which might be developed at the leeward hinge under excessive wind pressure, auxiliary leaf hinges were provided using 6-in. plates and bent angles to form a hinge flexible under rise and fall of the arch. The total weight of the two arches is 360 tons, and the bridge was completed and accepted on February 20th, 1916.

CORRESPONDENCE.

"ECLIPSE OR EMPIRE."

In your note on the book "Eclipse or Empire" in the *Journal* of November 3rd, 1916, you charge Dr. Gray and myself with reproducing a "sadly fallacious set of tables" from which you say the reader is asked to believe that the American operative is the equal of from one and a half to three English wage-earners. The argument on which this conclusion is based is in no way dependent, as a matter of fact, upon these figures. It rests on such indisputable facts as that wages in America are two or three times as high as they are here, though the wholesale selling prices of many commodities are no higher; and that, as shown by an American Government report issued in 1904, the American bootmaker produced 700 to 800 pairs of boots against the Englishman's 300 to 400 on the same machine. The figures quoted from the two Censuses of Production are cited merely as an illustration of a tendency established by a great mass of cumulative evidence. I do not doubt that these figures are "fallacious" in detail. It is almost inevitable in figures covering the activities of entire nations. But may I express my surprise at the particular instance you have selected for criticism? The only importance these figures have, so far as the book is concerned, is the presumptive evidence, such as it is, which they afford that this country is failing to keep pace in the industrial race. You reply that the American and English silk industries have nothing in common but the name, and therefore the figures are valueless. Unhappily the British silk industry is one of those in which no proof from this or any other source is required of the relative failure of our trade. "The silk industry," as Mr. Farrell, one of the largest British silk manufacturers, remarks in his article in "Eclipse or Empire," "is one which—for various reasons, mainly economic—has declined very considerably in this country since the middle of the last century." The decline of British industry—and the danger involved in it—is the warning which the book was written to give. In the case of silk, the fact is so thoroughly established that the precise interpretation of the figures is really irrelevant.

SAMUEL TURNER.

The note in question had reference simply to one or two specific points of textile interest contained in Messrs. Gray and Turner's book, and made no profession of evaluating its total contents. No probable harm can come of disseminating a crude comparison among persons qualified to realise the difference of the industrial situation in the two countries. Upon the other hand, mischief may be done by sowing broadcast figures which are very far from mirroring the whole truth. The authors confessedly found their tables in the English monthly reviews. They may be referred for more of the same style of thing to the original source, a pamphlet on "Foreign Tariffs and Industrial Conditions," issued from the Government offices at Washington in 1913. They will find that only a selection from the originals was made by the compiler.

The comparisons of textile efficiency are hopelessly vitiated by the differences of character in the goods produced, and it will be found that British industries, which in seeming have not a statistical leg left to stand upon, have remarkably little trouble in vindicating their real character in the open markets. The remarks were not intended to disparage Mr. Turner's well-meant efforts to spur British industry on to new enterprises. There may be a difference of opinion, however, as to the help given in that direction by figures so far divorced from fact. The silk industry was instanced as an extreme example of the fatuity of the comparisons; but Mr. Turner is at liberty, if he chooses, to turn to the cotton and woollen and worsted trades, which have by no means declined in the last half century.

THE WRITER OF THE NOTE.

OBITUARY.

SIR HOWARD WARBURTON ELPHINSTONE, BT. —By the death of Sir Howard Warburton Elphinstone, which took place on the 3rd inst. at his residence in Wimbledon Park, the Royal Society of Arts has lost its third oldest member, he having been elected in 1859.

Sir Howard was born in London in 1830. His grandfather was created a baronet for services rendered in the Peninsular War, and his father, who represented Hastings and subsequently Lewes in Parliament, was for some years a member of the Bar. Sir Howard was educated at Eton and at Trinity College, Cambridge, where he obtained a scholarship. He was Seventeenth Wrangler in the Mathematical Tripos of 1854. After acting for some time as Librarian of his College, he was called to the Bar by Lincoln's Inn in 1862; in 1869 he was appointed Lecturer to the Incorporated Law Society; and in 1889 Professor of Real Property to the Inns of Court. In 1895 he became Conveyancing Counsel to the Court.

Sir Howard's name has been well known for many years as the joint author with Mr. Key of "Precedents in Conveyancing." Besides this his principal works were: "Introduction to Conveyancing," 1871; "Patterns for Turning," 1872; "On the Interpretation of Deeds," 1886; and "On Searches," 1887; and he was also joint editor of "Goodeve's Real Property," 1897, and "Goodeve's Personal Property," 1892. He succeeded to the baronetcy on the death of his father in 1893.

SECOND LIEUTENANT CHARLTON WILLOUGHBY HOUGHAM FOORD.—Second Lieutenant Charlton Willoughby-Hougham Foord, Machine Gun Corps, died on December 19th, 1916, of wounds received on the previous day. He was the only son of Alfred Stanley Foord, of Laurel Road, Wimbledon, and was just thirty-one years of age. He was educated at Dulwich College, and after having served an apprenticeship with Messrs. Gwynne, engineers, Hammersmith, he entered the firm of Messrs. Marks and Clerk, consulting engineers and patent agents, being in charge of their branch office in Southampton Buildings from March, 1911. He was passionately fond of music, and particularly interested in wind instruments, himself playing the clarionet, and in February, 1914, he contributed an article "Air Pressures in playing Reed Instruments" to the *Philosophical Magazine*, the result of experiments made by himself. Keenly interested in shooting, he was an excellent shot, and entered for some notable competitions at Bisley. He enlisted in June, 1915, in the R.N. Anti-Aircraft Corps for foreign service, but finding that corps was no longer sending men abroad he obtained, in January, 1916, a commission in the Army, being gazetted to The Buffs. He was sent to Ireland for training, and was employed in the suppression of the Sinn Fein Rebellion. In June, 1916, he was transferred to The Queen's, and was to have gone to France in September, but was transferred to the Machine Gun Corps, with which he went out to the front in November last. His commanding officer writes: "Though only a short time with us he had endeared himself to all by his devotion to duty and cheerful disposition under very trying conditions." He had no fewer than sixty-five relatives serving their country since the outbreak of war. He was elected a Fellow of the Royal Society of Arts in 1911.

GENERAL NOTES.

GERMAN SHIPPING.—Captain Schroeder, in a lecture before the German Institute of Science of Navigation, stated that since the outbreak of war 152 German ships, representing 452,000

registered tons, had been destroyed by mines or torpedoes; 267 ships, with a cargo capacity of 807,000 tons, had been captured by the enemy and turned to his own use; and 621 merchant ships, of 2,341,000 registered tons in all, were lying interned in neutral harbours. In German harbours are 490 steamships, of a total of 2,400,000 registered tons. This means that 7·5 per cent. of German tonnage is irrevocably lost, 13·4 per cent. is in the hands of the enemy, 39·1 per cent. is in neutral harbours, and 40 per cent. in Germany.

The Influence of Foreign Ingredients on Steel.—An important paper by Dr. J. E. Stead, read at the annual meeting of the Iron and Steel Institute recently, discussed the effect of small quantities of phosphorus, sulphur, manganese, copper and tin on the qualities of steel. Attention is drawn to the need of greater precision in describing experiments on various steels. For example, in recording the results of tests of tensile strength, the dimensions of the test-pieces should be stated, and, in dealing with normalising and annealing, the temperature of heating and the time of cooling to below redness should be recorded. Speaking generally, the deleterious effects of impurities appear to have been exaggerated. Thus the effect of phosphorus within 0·1 per cent. is comparable with that of carbon, and 0·13–0·20 per cent. is desirable to give good machining properties. Phosphorus alloyed with iron also makes the metal less liable to corrosion. While sulphur *per se* may cause "red-shortness" in small quantities, it is actually beneficial provided manganese is also present. Silicon up to 1·5–1·75 per cent. increases the limit of ductility and tensile strength, while copper, in quantities less than 0·5 per cent., has little or no influence on the mechanical properties. Tin, however, in any sensible quantity should be avoided, as it makes the steel difficult to roll, and hard and stiff when heated.

An Electric Bread and Butter Machine.—The American bacon slicer is common enough in grocery stores, but the bread and butter machine, which is of British manufacture, is somewhat unusual. It is designed for operation by a ¼ h.p. direct-current motor, which drives it by a narrow belt passing round the periphery of a large flywheel. There is a large rotary slicing knife, a cylinder containing the butter, and a long trough which holds the loaf. The mechanism provides for adjustments which make it possible to regulate, as desired, the thickness of the slice of bread and the amount of butter which is spread on the slice. Once the mechanism is set for these, the machine will continue indefinitely to turn out slices at the rate of about 3,600 per hour. The butter is evenly spread over the slice, and it is quite immaterial whether the bread put into the machine is new or stale; the makers of the machine state that "new bread is perfectly cut and buttered within two hours of baking." According to the *Electrician*, a large number of shipbuilding works on the Clyde have been supplied with machines.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

January 24.—W. A. M. Goode, Hon. Secretary, National Committee for Relief in Belgium, "Relief Work in Belgium."

January 31.—Miss Ella C. Sykes, "The Work of the Y.M.C.A. in France."

February 7.—Robert Fortescue Fox, M.D., "The Future of British Spas." Sir Thomas Barlow, Bt., K.C.V.O., F.R.C.P., M.D., LL.D., F.R.S., will preside.

February 14.—Lawrence Chubb, Secretary to the Commons and Footpaths Preservation Society, "Highways and Footpaths."

Indian Section.

Thursday afternoons, at 4.30 p.m. (except where otherwise announced):—

January 18, at 4 p.m.—Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus. The Ben-i-Israel." The Right Hon. Viscount Bryce, O.M., D.C.L., LL.D., F.R.S., will preside.

February 15.—Professor H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial College of Science and Technology, "The Indian Silk Industry."

March 15.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

April 19.—

May 17.—Surgeon-General Sir C. Pardey Lukis, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

January 30.—Octavius C. Beale, Representative and Past President of the Australian Associated Chambers of Manufacture, "Imperial Industries after the War."

February 27.—Alfred Bigland, M.P., "Imperial Assets and how to use them."

MARCH 27.—The HON. FREDERICK W. YOUNG, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced :—

JAMES HARRIS VICKERY, LL.B., "German Business Methods."

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time : its National Importance."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

HOWARD LECTURES.

Monday afternoons, at 5 p.m. :—

WILLIAM RIPPER, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m. :—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 5, 12, 19.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 15...Victoria Institute, Central Buildings, Westminster, S.W., 4.30 p.m. Very Rev. W. R. Inge, "Christian Mysticism."

Bibliographical Society, 10, Hanover-square, W., 5 p.m. Mr. A. Bolton, "Robert Adam, the Architect, as Bibliographer and Builder of Libraries."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. Marie C. Stopes and Dr. R. V. Wheeler, "The Constitution of Coal." 2. Dr. R. Lessing, "A New Method of Extracting Vaporous Constituents from Coal Gas."

TUESDAY, JANUARY 16...Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Professor J. T. Morris, "The 'Lumen' as a Measure of Illuminating Power."

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Forbes-Leslie, "The Occurrence of Petroleum in England."

Statistical Society, King's College, Strand, W.C., 5.15 p.m. Baron A. Heyking, "The Economic Resources of Russia, with special reference to British Opportunities."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Old Brain and the New Brain, and their Meaning." (Lecture I.)

Photographic Society, 35, Russell-square, W.C., 7 p.m. Messrs. A. B. Hitchins and F. B. Gilbert, "A Shutter-Testing Machine."

WEDNESDAY, JANUARY 17...Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. W. L. Nash, "Egyptian Magic."

Meteorological Society, Caxton Hall, Westminster, S.W., 5 p.m. 1. Annual General Meeting. 2. Major H. G. Lyons, "The Winds of North Africa."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. Janet Lane-Claypon, "Principles of Organisation and Administration in Child Welfare."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor Sir Henry Newbolt, "The Poet and his Audience."

Aëronautical Society, at the Grosvenor Gallery, Bond-street, W., 8.30 p.m.

Microscopical Society, 20, Hanover-square, W., 8 p.m. Presidential Address by Mr. E. Heron-Allen, "Alcide D'Orbigny, his Life and Work."

THURSDAY, JANUARY 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. (Indian Section.) Sir Thomas H. Holdich, "Between the Tigris and the Indus. The Ben-i-Israel."

Linnean Society, Burlington House, W., 5 p.m. Professor F. O. Bower, "The Comparative Morphology of the Sorus of Ferns."

Chemical Society, Burlington House, W., 8 p.m. Colonel C. T. Heycock, "Alloys of Copper, Tin, Aluminium, and Gold."

Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir Walter Raleigh, "The Strength and Weakness of Romantic Poetry." (Lecture I.)

Historical Society, 22, Russell-square, W.C., 5 p.m. Mr. A. F. Sieveking, "Duelling and Militarism."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

Economics and Political Science, London School of, Clare Market, W.C., 5 p.m. Mr. E. J. P. Benn, "The Organisation of Trades."

FRIDAY, JANUARY 19...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor Sir James Dewar, "Soap Bubbles of Long Duration."

University of London, University College, Gower-street, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture I.)

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Messrs. A. G. Cooke, W. J. Gow, and W. G. Tunnicliffe, "The Manufacture of Gauges at the L.C.C. Paddington Technical Institute."

SATURDAY, JANUARY 20...Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. R. Hinks, "The Lakes and Mountains of Central Africa." (Lecture I.)

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FRIDAY, JANUARY 19, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 24th, at 4.30 p.m. (Ordinary Meeting.) W. A. M. GOODE, Hon. Secretary, National Committee for Relief in Belgium, "Relief Work in Belgium."

INDIAN SECTION.

Thursday afternoon, January 18th; The RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., in the chair. A paper on "Between the Tigris and the Indus. The Ben-i-Israel," was read by COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

COAL AND ITS ECONOMIC UTILISATION.

By JOHN S. S. BRAME,
Professor of Chemistry, Royal Naval College, Greenwich.

Lecture III.—Delivered December 11th, 1916.

Consideration may now be given to the means which are open to us for the more economical utilisation of our coal, and the natural course will be to deal first with wastage in production. In the past coal-mining has been characterised by the little regard which has been paid to wastage of good coal, often, of course, through financial considerations. The Royal Commission (1905) directed attention to many possible economies, such as those possible through the more extended use of coal-cutting machines, and of plant for the treatment of small coal to enhance its market value.

Many of the losses of coal are unavoidable. Barriers, for example, must be left between adjoining properties, and these often have to be of considerable thickness in the vicinity of old workings, where there is risk from water or foul gases. Barriers between properties will obviously be reduced by mining operations on a larger scale, as, for example, when seams are worked by large concerns, also by amalgamations. Further, large scale operations lead to abolishing irregularities in the boundaries. Then there are barriers in the pits, and pillars left as supports. It may be intended that these shall be worked out, but the cost of doing so, and the crushing the coal undergoes, often prevent this being done.

The Royal Commission (1905) in estimating the coal reserves made allowances varying from 15 to 30 per cent. for coal which had to be left underground, the average deduction from the total coal being 22·7 per cent.

There are unavoidable losses also in winning the coal by reason of the small dirty coal produced; but a great deal of really good coal is often wasted because it does not pay to bring it to bank. If coking is not carried out at the pit, there may be no profitable outlet for such small coal. On the other hand, by proper treatment of small coal, it can be rendered serviceable for such purposes as steam raising—a use to which the introduction of mechanical stokers has greatly contributed.

Large quantities of good but small coal have been left in the worked-out areas, in many cases giving rise to "gob" fires through spontaneous ignition. In cases where such small coal has been recognised as likely to ignite, it has been brought to bank and thrown on the tip.

There has been very considerable extension of the use of coal sizing and washing plant of recent years, but even now we are far behind Continental practice. By the use of such plant much small coal which was at one time not marketable at a profit now fetches remunerative prices. The use of such coal for steam raising naturally conserves for special uses the better-sized coal.

Then, again, where the coal was of a suitable character, coking of the small coal became general, the earlier ovens being of the very wasteful beehive type; but it must not be forgotten that, although these ovens are extremely wasteful and the "bogey" of fuel economists, they really contributed to economy in production, although such contribution was far less economical in itself than it need have been. It is a fact, however, that large quantities of coal which would never have been considered worth bringing up but for the introduction of the beehive ovens have been converted into valuable fuel.

In some districts, however, the waste of small but nevertheless good coal is still tremendous. Professor Henry Louis has stated that in the Nottingham coalfield he has seen coal loaded into the tubs with forks having tangs $1\frac{1}{2}$ in. apart, all the coal which these forks did not raise being thrown into the "goaf."

Another contributing factor to the waste of small coal has been payment based on large coal produced—a system devised to encourage the production of a higher percentage of large coal. In this it doubtless had the desired effect; but although less small was produced, such small could not be profitably marketed if it had to bear the same charge for working.

Any system which reduces the quantity of small coal produced in working, providing it is not handicapped by such considerations of payment, will clearly be on the side of economy. By the use of coal-cutting machinery, the advantages of which were emphasised by the Royal Commission (1905), less small coal is produced, and it is often possible to do the cutting in the underlying strata instead of in the coal itself. Thin or hard seams which cannot be worked profitably by hand can often be won with machine cutting.

Most cutting machines are in use in the Yorkshire and Midland coalfields; in 1913, 2,892 of these machines were in operation in this country.

There is one and a very reprehensible practice which leads to waste of coal which should be utilised, and that is the working of only the best seams, or even the best part of one seam, where it is fairly thick and of two kinds. Working of only the best seams often leads to such damage of the less valuable coal that it afterwards does not pay to win it. As an example of the waste of coal through working part only of a seam, in the Mines Report (1910) it is stated that in places the valuable Barnsley seam is worked only for the hard lower portions, the top softer coal being rejected. This soft coal is often 4 ft. thick, and it was estimated that some 40 per cent. of the whole thickness of the seam was left in the pit. Beyond its softness, it is just as good as the hard coal.

With the introduction of coking plants, where suitable coals are worked, of briquetting plants, as in South Wales, for the treatment of harder coals, and of sizing and washing plants, the amount of small coal wasted has been very materially reduced, and the increased price for such prepared coals has proved an important factor in the economy of coal.

By washing coals, not only is the earthy matter greatly reduced, but also the quantity of pyrites, which lowers the sulphur content of the coal (or coke)—an important consideration for metallurgical uses. The picking, sizing and washing, moreover, effect the removal of such dirt as is inevitable when cutting machines are worked in the underlying strata, and in this way indirectly contribute to economy.

At most modern collieries the arrangements for handling the coal, for picking and sizing, and for washing are very complete; but there is still a lot of fine dust from screens and "smudge" from washing plants to the profitable utilisation of which attention might be directed. The former would appear most suited to dust firing if properly treated.

The quantity of coal consumed in working a pit often represents an unduly high proportion of the output. True, it is often very poor quality coal which is so used, and because of the difficulty of finding a market, and because its quality is so low that it cannot carry transport charges, there has been little incentive to economy, which would often mean incurring capital charges for more efficient power plant. It is not unusual to find reciprocating engines of very low efficiency in use at pits, non-condensing engines are not uncommon, and steam is often carried considerable distances.

It is difficult to estimate the waste which occurs at the pithead, or what proportion of the output is used for the actual colliery operations. The British Association Committee hopes to collect some reliable data on the point. Professor Henry Louis has estimated that the average consumption at the pit is 7 per cent., equal to the large total of 20 million tons.

Where operations are on a sufficiently large scale, gas-producer plant has been installed with considerable economy. Not only is power

obtained at a low cost, but sulphate of ammonia is recovered, and in some cases fuel so poor as to be useless for steam raising when burnt under boilers can be gasified, so that saleable coal which would otherwise be used at the pit comes on the market.

Where groups of pits exist the installation of a central gas-producer plant, from which electrical power could be distributed to the individual collieries, would in many cases be a sound procedure. Again, in the North-East Coast power scheme, collieries generally take their power from the system, and this has led to great savings.

Professor Henry Louis, in the discussion on the Fuel Economy Committee Report at the British Association in September last, stated that by stopping colliery waste the saving to be effected would be as great as by all other methods of economising fuel put together (see *Engineering*, September 22nd, 273).

Turning now to economy in use, it was shown in the first lecture that some 60 million tons of coal are employed in factories, and the bulk of this is for power production. It can be stated that of the potential heat units in this coal we certainly utilise less than 10 per cent.

With our present knowledge of methods of getting power from coal, the best utilisation we are likely to effect (by gasification and use directly in gas-engines) will be about equal to 20 per cent. of the available energy.

From the Census of Production (1907) the power developed in the United Kingdom and the means of generation are :—

10,578,475	Horse-power developed.
680,177	By internal-combustion engines.
117,907	By water.

Considering next the relative efficiency of power plants, taking the over-all efficiency, *i.e.* boiler (or producer) and engine, the following figures are approximately correct :—

Type of Engine.	Approximate Over-all Efficiency.	Equivalent lbs. of Coal per h.p.
Steam.		
Small reciprocating, non-condensing	5	4–5
Large multiple expansion, condensing	6–7	3–4
Large turbine sets	15	1·4
Producer Gas	20	0·9–1·1
***Oil.* Diesel type**	30–33	0·45-0·5 (oil)

These figures are average figures for good practice, but with steam plants very frequently much lower figures are obtained through faulty operating.

Economy in operating can be obtained by more attention to combustion. The losses through large excess-air supply and the method of checking these losses by the record of carbon dioxide in the flue gas have been dealt with in a previous lecture.

Further, in the majority of cases coal is purchased with but little regard to its heat value. It is generally recognised now that the industrial value of coal for heating is broadly proportional to its calorific value, and now purchase based on the calorific value, payment being made on a sliding scale, is generally recognised as sound, and has already been adopted by several large concerns in this country. Once the producer is convinced that all the benefits are not to be on the side of the consumer, that the supply of coal of better quality will bring a correspondingly better price, the very natural opposition to such a method of purchase on the part of the seller will disappear.

The combination of the purchase of coal on a scientific basis with scientific control of combustion leads to very considerable economies, and for some years I have advocated the employment by all large coal consumers of trained fuel experts—a course which would lead to savings far greater than the remuneration of the expert. Some large consumers have already adopted this plan.

Post-graduate courses of instruction in such work are carried out at the Imperial College of Science and Technology and at other technical colleges. In the evening classes held under my direction at the Sir John Cass Technical Institute over ninety students have undergone instruction in the period 1909–14: most of these were either engaged in the control of power plants or in industrial operations where coal was an important factor.

In the whole scheme of coal economy it will obviously be desirable to employ the form of plant which gives the highest thermal efficiency, for by such plant the lowest fuel consumption will be attained; but many other considerations besides thermal efficiency will be taken into account. It has been shown above that the gaseous fuels derived from coal used directly in gas engines give a higher thermal efficiency than any form of steam plant. It was to gaseous

fuel that the Royal Commission (1905) looked for the realisation of enormous economies in coal consumption. On the computed consumption of from 40–45 million tons employed in factories, it was estimated that a saving of 20–30 million tons was possible. On the total industrial consumption of 143–168 million tons, the estimated possible saving was 40–60 million tons.

Since that date, however, the steam turbine has developed and, although inferior as a heat engine to the gas engine, has proved a more serviceable power unit for large-scale power production than the gas producer and gas engine.

With the erection of the large Mond gas plant at Dudley Port, in Staffordshire, and the distribution of power gas at a cheap rate throughout the district, great hopes were raised that similar plants would be installed in other industrial districts. The cost of distribution of gas of such low calorific value must be high, very large mains being required. Further, according to figures by Mr. Humphrey, it would appear that the heat units in the gas distributed represented rather less than 50 per cent. of the heat units in the coal gasified. Further schemes on similar lines have not developed, and power distribution on a large scale will follow on the lines of electrical generation.

For power production and distribution as electrical energy on a large scale, the turbine has practically completely supplanted the gas producer in the opinion of engineers. For one thing, the largest gas-engine units are far smaller than even moderate-sized turbine sets, the latter now running to 25,000 k.w., and even much larger units in America, and economy in every way results from the employment of the largest possible units; again, the lower cost of a steam-turbine installation, general economy in use and greater reliability have convinced engineers of the advantages of turbines as a whole over the gas plant, in spite of the higher thermal efficiency of the latter.

Raw coal is, however, almost invariably used for the generation of the steam, so that its valuable nitrogen is entirely wasted, together with other by-products. This has led to the suggestion that coal should be gasified and the gases used for boiler firing. In such practice the producer efficiency would not exceed 75 per cent., and the efficiency of the boiler under gas firing would probably be about 70 per cent., giving an efficiency in all of about 52 per cent. (not including the engine). On the other hand, a good boiler plant with coal firing would give an efficiency of 80 per cent. Allowing, then, that with the producer and gas firing an efficiency as high as 55 per cent. was obtained, there is a difference of 25 per cent. in favour of coal firing; and this would obviously have to be made up by the value of the by-products, which could only be produced in a plant much more costly in the first place, carrying, therefore, higher capital charges — a type of plant admittedly more costly to operate, and requiring far more attention than a machine-stoked boiler installation.

It would not pay, therefore, to use coal in this way; either the coal must continue to be burnt without treatment, in the usual way, or if gasified used directly in gas engines, the superior efficiency of which would compensate to a considerable extent for the poorer efficiency of the gas-steam plant. Here, again, the difficulties of large gas units come into the question.

Producer gas plants with gas-engines, however, have their proper sphere in the economy of coal, and have contributed very largely to economy. When required for furnace heating as well as power, gas plants are commonly installed, and as in such cases large quantities of gas have to be produced, recovery of by-products pays. In moderate-sized power plants, again, the gas producer with gas engines is economical, the absence of by-product recovery leading to simplification of working and cost of both installation and operating.

Another highly important point is that a class of coal totally unsuited to use for steam raising can be employed in a producer, so that good steam-raising coal is economised.

The introduction of suction gas plants, practically automatic in their action, except for the introduction of fresh fuel at intervals, and giving a very low fuel consumption of almost 1 lb. per b.h.p., has also been a great advance, because such plants have almost invariably been installed in place of moderate and small-sized steam plants, the latter being notoriously inefficient as power units.

Coal gas has become a fuel of considerable industrial importance both for heating and power production. Its applications for industrial heating are most wide and varied—on a comparatively large scale it is employed for furnace heating, such as muffle and other furnaces for the treatment of steels, and for metal melting, where fuel costs have been very materially reduced, besides advantages arising from reduction of labour, reduction of melting losses, and of cost of crucibles. In competition with other

forms of heating, coal gas has been selected and installed at the Royal Mint for all melting purposes.

In many of our principal towns the price of coal gas is so low that, combined with its efficiency, it offers many advantages both for power production and heating. In many towns the special price for such purposes lies between 1*s.* and 1*s.* 6*d.* per thousand cubic feet.

Turning from the use of coal and its products for industrial purposes, brief consideration may be given to their use for domestic purposes. It was shown in the first lecture that this domestic consumption probably amounts to 35,000,000 tons per annum, and in addition to this it must be remembered that a very considerable amount of coal gas and coke, and some electric energy, derived from coal, are also employed.

In the use of raw coal in the domestic grate we have at once perhaps the most comfortable form of heating and the most wasteful it is possible to devise. A table which I may quote from Professor Lewes gives the distribution of heat units from the coal fire as :—

Much improvement in efficiency may be looked for in the construction of better grates. Mr. A. Vernon Harcourt, F.R.S., recently discussed this question before this Society (*Journal*, 1915, LXIII. p. 570), and pointed out that our grates were fundamentally wrong in not giving horizontal radiation. He described his own form of grate, which possessed the great advantages of maximum radiation surface, this surface being vertical, and therefore highly efficient. Moreover, it burns coke perfectly, and so a hot, efficient and smokeless fire is obtained.

We must recognise also the great advances which have been made in the application of coal gas for domestic purposes, for heating, for cooking, and for the maintenance of hot water in the system usually dependent upon the closed range. Mr. F. W. Goodenough has dealt with this subject in Cantor Lectures (1913). It is sufficient to say here that since that date there has been further improvement in stoves and hot-water appliances. In some of the former a radiation efficiency of over 50 per cent. has been attained. It is no wonder that heating by coal gas has made marked progress, to the

In gas—5 cubic feet at 570 B.Th.U.	2,850	Lost 81 per cent.
" tar—·05 lb. at 15,200 "	760	
" moisture, volatilisation, etc.	1,450	
" products of combustion	6,000	
" grate and ashes	265	
" radiant heat from coke	2,485	Used 19 per cent.
" " " flame	190	
Total heat units per lb.	14,000	

improvement of our atmosphere and the reduction of fogs, to say nothing of the purely domestic advantages in the reduction of dirt, dust and work. It is equally or even more true that the same advantages arise from electricity; but, except where current is much cheaper than in London, the use of electricity for general heating is too expensive.

Another very important point is that the open fire is notoriously a bad smoke producer. It has been estimated that 70 per cent. of the smoke over towns, other than large industrial towns, is due to domestic fires. It is universally admitted that the abolition of this smoke would be a great blessing, and it cannot be gainsaid that very considerable reduction has resulted from the great extension of the use of gas for heating and cooking.

But the open grate is unlikely to be generally disestablished in popular favour, partly perhaps because of fancy and custom, partly on the good grounds that for living rooms heated air without a source of radiant heat also is unsatisfactory, and largely because, owing to the great natural sudden variations of temperature, systems of heating by closed stoves or hot pipes are not suited to the conditions. It remains, therefore, either to find a more suitable fuel which is smokeless, such as coke, or to extend further he use of coal gas and electric heating.

The utilisation of gas coke for domestic purposes provides an important outlet for the surplus from the gasworks, and the demand at the present time is very large, the high price of coal and the difficulties in securing delivery being contributing factors. While admittedly imperfect in many ways, it is not only a useful fuel but a smokeless one. In the ordinary way of wet quenching the coke often carries an undue proportion of water, which detracts from its value as a fuel in the open grate; but systems of dry quenching are now frequently employed. Other factors against coke as a fuel are the frequent high ash content, difficulties of ignition,

and the necessity for the use of a proportion of coal with the coke in most open grates.

Because of these disadvantages great hopes are placed upon coke obtained by carbonisation at temperatures of about 500° C. instead of at temperatures of over 1000° C., as in gasworks practice.

"Coalite" was a fuel of this type, and there can be no question but that low-temperature coke is an almost ideal smokeless fuel. Such coke contains from 8 to 10 per cent. of volatile matter, which enables a fire to be kindled without the aid of raw coal, and perfect combustion to take place in open grates. It is to low-temperature coke that most enthusiastic advocates of the prohibition of the use of raw coal for domestic purposes are turning for a solution of the problem of a smokeless domestic fuel, and on the successful production of which they are relying for the hoped-for legislation.

But, as Mr. Butterfield has pointed out, great as are the advantages of such cokes, they suffer from some inherent disadvantages of all coked coal, one being its bulk in relation to heat units, giving an unduly high stowage value, a matter of some importance, reducing as it does cellar accommodation in terms of heat units. Most of these cokes have, up to the present, been also unduly "tender," so that they do not stand well in transport. Unless backed by legislative enactment, producers of these soft cokes will have to sell at an appreciably lower price than coal—the appeal of smokelessness and quality will be to the few otherwise—but there seems little doubt but that this can be done.

Passing from the consideration of these cases where economy is possible in the ordinary ways of employing coal, or fuels prepared from coal, there are two very important industrial operations where great saving is possible, even although considerable progress has been made in reducing this waste. These are the waste of heat in blast-furnace and coke-oven practice.

The old open-throat blast furnace is almost a thing of the past, but even where the combustible gases from the furnace, not required for heating the stoves which provide the hot blast, are used for power production, this utilisation of the surplus is often carried out in an uneconomical manner. Often this is because there is more than sufficient for the actual operations of the plant and there is no outlet, in the absence of any collective waste-heat scheme, for the surplus power which the gases are capable of giving.

The available surplus power from blast furnaces amounts to a very large figure. Approximately, for every ton of iron produced, 150,000 cubic feet of gas of a calorific value per cubic foot of 90 to 100 B.Th.U. are obtained. After heating the blast stoves and operating the plant with gas-driven engines, a surplus of 65,000 cubic feet may result, this being equivalent to an output of about 650 b.h.p. In 1913 there were 337 blast furnaces in operation, the output of pig iron being 10,260,315 tons. It would entail the expenditure of a large amount of capital to put many of these plants into a condition for the profitable use of the surplus gas; again, until collective systems of power distribution are established in the districts, means are not available for the distribution of the energy; but such enormous waste of energy is taking place that its proper utilisation is a matter of great importance. At one large iron and steel plant, where a modern system of utilising the gas was installed, on four furnaces it was estimated that the weekly saving in fuel was equivalent to £1,000.

The second case of waste of available energy on a large scale is also closely connected with the iron industry, namely, the waste in many coke-oven plants. The beehive ovens originally put down for the conversion of much small coal for which there was no remunerative outlet were extremely wasteful, both in giving a lower yield of coke and in waste of heat and valuable by-products. By coking in suitable large chamber ovens, and utilising the regenerative system by which the hot gases on leaving the flues are made to impart their heat to the air supplied for combustion, it is found that a large proportion of the gas produced is available for purposes not connected with the actual coking operation. In addition, the yield of coke from a given coal is materially increased, and valuable by-products, identical with those from ordinary coal-gas manufacture, are recoverable.

The surplus gas available per ton of coal carbonised is about 5,000 cubic feet, and its calorific value about 550 B.Th.U. per cubic foot, so that a coke-oven plant carbonising 400 tons per day and giving the above amount of surplus gas will, with the consumption of 21 cubic feet per b.h.p., operate a power plant with an output of 4,000 b.h.p. per hour.

There has been a fairly rapid replacement of the old wasteful beehive ovens in recent years (of which the output of sulphate of ammonia shown in Fig. 3, p. 155, is a comparative measure); but in 1913, of the 20 million tons of coal

converted to coke, about one-third was worked in beehive ovens, and 13,000 of these were still in use. In 1914 the number had been reduced to 9,210.

Surplus coke-oven gas is being utilised as a source of power for the supply of the collieries, or in connection with a "waste-heat" scheme, in admixture with producer gas for steel making, and as supplementing the supply of coal gas in the neighbourhood. On the Continent and in America large quantities of coke-oven gas are used in this way. Arrangements have recently been made by the City of Leeds Gas Committee for the daily delivery of one million cubic feet of coke-oven gas from the plant at Middleton, this being about one-fifteenth of the maximum daily output of coal gas. Provision is made for delivery in regular quantities each hour, and the quality of the gas is checked by recording gas calorimeters.

Where coking plant is able to deliver such gas to a neighbouring gas company very considerable economy in coal is possible; but because of the statutory obligations of gas companies to maintain a constant service, it will still be necessary for most illuminating gas to be made specially, as a coke-oven plant is dependent on the iron trade for its activity, and, unless it is certain that a plant can be kept in operation, a gas concern largely dependent on it might be placed in serious difficulties.

Great as savings would be which can be realised by individual action, they are small as compared with what might be realised by collective action throughout a district.

Through electric generation and distribution every advantage may be taken in most of the big industrial districts of Great Britain of the principal supplies of waste heat, such as from coking plants and iron furnaces. The extensive scheme which has been in operation on the North-East Coast for some years is an object-lesson in what can be accomplished; but even here conditions are not such that the maximum economy is possible.

The district is one in which collieries, coke ovens and blast furnaces are operated in large numbers, and although some local utilisation of waste heat in individual cases is possible—for example, from a coking plant to the colliery —much greater advantage lies in pooling the waste heat to a central electric distribution system.

The underlying principle is to have a uniform collecting and, therefore, distributing electric system. Waste heat from coke-ovens, blast furnaces and exhaust steam from blowing engines (through low-pressure turbines), is utilised continuously at maximum electrical output, and the supply supplemented as necessary from steam-operated turbine sets at a limited number of stations.

Power is actually taken from producers and returned to them in such amounts as individually required at a cheaper rate than they could actually produce at, thereby leading to great savings on the part of the producers, who are spared the expenses of stand-by plant which would be required without this co-operative principle.

In this district at the commencement there were six coal-fired generating stations and five waste-heat stations. Now there are eleven waste-heat stations and two main steam generating stations. Several small uneconomical stations have been closed.

The area covered by the scheme is 1,400 square miles; the length of the district (north to south) is seventy miles; and the present total horsepower generated, 343,000. Great savings in the coal consumption of the district (especially for collieries) have resulted, and the cheap current has practically abolished the individual generation of steam power; collieries with an output of over 20 million tons now depend on this supply, and show a saving of about 75 per cent. in coal consumption (equal to one million tons of coal); the suburban railways are supplied with electric power for eighty miles of single track; heavy freight haulage is carried out on fifty miles of track; tramway systems are supplied with current. In addition, lighting is provided in towns with an aggregate population of 700,000.

Another important feature is the development of new industries, notably electro-chemical.

One essential point in such a scheme is to maintain a high load factor, which is only possible when there is a great diversity of use for electricity throughout the whole day.

The North-East Coast scheme has gone some way towards the realisation in one district of the prophetic vision of general electrification of the country with which Mr. de Ferranti startled the country in his Presidential Address to the Institution of Electrical Engineers in 1910.

Mr. de Ferranti estimated that by conversion of all coal used for power into electrical energy in the producing area, 60 million tons of coal would do the work of 150 million tons at present used, providing a load factor of 60 per cent. could be maintained. With this saving in coal

there would accrue also the advantages of reduction of coal consumption, abolition of labour in transporting coal, the abolition of smoke and dirt, and the provision of vast amounts of sulphate of ammonia which was to render England independent of imported food supplies.

Such visions are by no means impossible of realisation, but there are many obstacles to be faced. No such system is practicable without unification—this is the essence of success, and one great difficulty is the present diversity of the systems of electric generation and distribution, which is so great that any comprehensive scheme would involve the scrapping of a large number of still efficient machines, and the large sums of money represented by municipal concerns and the investments of the public in electric power and light companies, have to be considered, together with the difficulties from the monopoly of rights of distribution in the districts. Before the expense of building up could be met large sums would be called for in compensating for these investments and monopoly rights, and generally arranging satisfactory amalgamation terms.

Some steps in the direction of more systematic distribution have resulted from present conditions, the Board of Trade having recently issued a circular in reference to the linking up of generating stations, and in certain districts this has been accomplished, one or more generating stations carrying the load in rotation, others remaining as stand-by stations. This linking-up will be further extended as the committees which have the matter in hand make the necessary arrangements, and considerable economy in fuel will result.

When we consider that our railways in 1913 carried 210 million tons of coal, and consumed a further large quantity in doing so, and that at the end of the journey the large part used for power production did not give a greater return than some 10 per cent. of its total heat units, the advantages to be gained by the use of the coal at the point of production, and distribution of its heat energy in the form of electricity at much higher efficiency, are obvious. But the distribution of electricity to areas far removed from those centres favourable to its production will probably be long deferred, as will also the general electrification of main railway lines, as there are many difficulties to be overcome. If, however, as many hope, our waterways are developed as a national concern after the war (a useful method of finding employment for the large numbers who will be returning to civil life) the introduction of electric haulage would be possible, and such a system would be of enormous benefit in the transit of heavy merchandise and a useful outlet for power from a large producing district.

Without going so far as a general power scheme over larger areas than the great industrial centres, there can be no question that enormous economies are possible in such areas because existing conditions are generally favourable. There has been a natural concentration of industries and population in the vicinities of our coalfields; the principal sources of waste heat—iron smelting, with its complement, coke manufacture—have developed naturally in the same areas. There is the large demand for power for industries, for locomotion, and for the general supply of heat and light to a large population.

But admitting the great advantages of electricity for distribution generally, especially over considerable distances, as compared with coal gas, the general use of coal gas and the value of its by-products place it in too strong a position to be overlooked as a most important factor in such a scheme. It has already been seen how coke-oven gas as supplementing coal gas does lead to economy in coal. The utilisation of the large quantity of coke available after all works requirements are met for the generation of power by gasification and the use of the gas in gas engines would enable the large gas concerns to be profitably linked in. Not only would a better economy in the use of the coke be obtained, but a large proportion of the nitrogen in the coke could be rendered available as a fertiliser.

Further, it is almost universally admitted that sooner or later low-temperature carbonising schemes for the production of a smokeless domestic fuel, which would have decided advantages over gas coke, will prove successful, and the development of such schemes should bring them also naturally into the one big scheme applicable to the district.

In the latest developments of these schemes arrangements are being made for the gas produced to be mixed with producer gas, obtained from cheap slacks and "smudge," and utilised for power production.

Such co-ordinated schemes for the better utilisation of our coal supplies will necessarily develop in the coal-producing districts. Here waste heat would be available from coking and blast-furnace plant; coke ovens might also

supply local gas undertakings with a proportion of their gas; from the gasworks power would be supplied to the system through the surplus coke; producer-gas plants would work on a large scale on the small and low-grade fuels at stations near the pits; the domestic fuel plant would provide the smokeless fuel for the grates (which would be supplemented by gas heating), and contribute through its gas to the power production. A few coal-fired plants with large units would serve to make up production to the full output, as required.

With such a scheme in operation there would be an enormous reduction in the amount of good coal used for steam raising. Although raw coal would still be utilised—a proceeding very reprehensible to some people, although capable of justification in a large number of instances—a very great addition would be made to the valuable by-products, sulphate of ammonia and tar; at the same time an all-round large reduction in the total coal used would be achieved.

One very important consideration arises in respect to the tar produced. Chemists are so impressed with the great value of tar as a source of raw material for industries of great importance that they are apt to overlook the possibility of overproduction, which would relegate much of the tar to utilisation for purely fuel purposes. Even in 1909 the price of tar was as low as 11*s.* per ton, and benzol was 6*d.* per gallon. The quantity of tar produced at present is approximately:—

	Tons.
From 17,000,000 tons coal at gasworks .	850,000
,, 13,000,000 ,, ,, coke-ovens .	650,000

In the near future practically all metallurgical coke will be produced in recovery plant, yielding another 350,000 tons. The position will certainly be, when the present big war-demand for tar products ceases, that there will be considerable overproduction in relation to the quantity normally necessary to furnish finished tar products.

The high-temperature tar will amply supply all raw material for special industries (benzol, toluol, carbolic acid, etc.), whilst the low-temperature tar, because of its greater fluidity, low free-carbon content, and the high yield of low boiling constituents suitable for motor spirit (but not so suitable for the production of the purer benzols and toluols as the high-temperature tar, by reason of the high proportion of other hydrocarbons), will find its use for fuel purposes. After distilling the lighter spirits off, the heavier oils will be soda washed to recover the high proportion of cresylic acids present, the residual oils being suited to use in internal-combustion engines of the Diesel type.

London is in a special and unique position as regards such a general-power scheme: it is far removed from coal-producing districts (at least, until there has been considerable development in Kent); it has an enormous population and big demands for power, although no large individual demands which compare with the big industrial concerns in the North; enormous demands for lighting and domestic heating.

The electricity supply system is simply chaotic, and many of the generating plants far too small for the best efficiency to be realised, as the following table, compiled from data in the valuable report furnished to the County Council by Messrs. Merz and McLellan in 1914, shows:—

Electricity Undertakings, Greater London, 1912.

Number of authorities	70
Total capital outlay	£25,997,399
Expenditure—plant and machinery	£8,059,601
Plant installed	307,338 k.w.
Generating stations (not including 9 traction)	70
Average size of units	632 k.w.
Number of frequencies	10
,, voltages, as distributed	24

Linking-up of stations and systems would, therefore, be very difficult and in many cases impossible, and to attain unification a tremendous amount of alteration would be involved; but the advantages to be gained by so doing, enabling, as it would, a considerable number of the least efficient stations to be closed, are evident.

Waste heat is not available in the London area, and current would have to be generated at large stations situated below London, necessarily on the river-side, so as to secure the advantages of sea-borne coal and ample water supply. For the most efficient scheme I feel convinced that the gas companies and future low-temperature carbonising concerns will have to supplement the directly generated current, the former being linked in by utilising surplus coke in producers and the gas in gas engines coupled with generators, the latter through their surplus gas, to be mixed with poor producer

gas (possibly the coke gas referred to). The gas companies already have their distributing system and market for gas; the low-temperature coke will find the best market in the country at hand.

In this way three important concerns, which would handle coal as their main raw material, could be linked up through the medium of the future uniform system of electricity distribution in the metropolis to the very great advantage of the community, providing cheap electricity, smokeless fuel, and retaining coal gas with its many advantages.

The spirit of aloofness and competition between gas and electricity might well be buried beneath the erection of a comprehensive power scheme for London and the surrounding districts.

Errata.—In Lecture II., in the table of Products from Crude Tar at the foot of p. 156, Toluene should be 0·6 per cent., and Phenol should be 0·2 per cent.

ANNATTO IN PORTO RICO.

Until the European war curtailed available sources of dyestuffs, the market for Porto Rican annatto was very limited. In the fiscal year 1913–14 there was exported 211,886 lb., valued at £2,753. The influence of war conditions began to be apparent late in 1914, when exportations rose to 337,299 lb., valued at £5,564. Since then the increase has been considerable in both quantity and price. Before the abnormal conditions annatto sold as low as 16*s*. 8*d*. to 20*s*. 10*d*. per 100 lb. At present it commands 54*s*. 2*d*. to 62*s*. 6*d*., according to quality.

According to a report by the United States special agent in Porto Rico, the supply of the product is extensive, as the tree grows wild. The collection of the seeds, which constitute the "annatto" of commerce, affords employment and a source of income to country folk, to whom any opportunity for earning money is a considerable boon.

The seeds of the bush or tree *Bixa orellana* are known commercially as annatto. The seeds yield a yellow colouring matter which has been employed in dyeing silk, cotton, and wool. The colour is somewhat fugitive. There is a widespread use in colouring confectionery, butter, cheese, sauces, varnishes, lacquers, and the like. The local name is "achiote."

If the present profitable prices continue, it is probable that the shrub will be planted on a large scale. *Bixa orellana* bushes a year and a half old yield, it is stated, from one-half to one pound of annatto. This amount increases as the plant becomes older.

EFFECT OF KELP HARVESTING ON FISHES.

A preliminary report of observations made to determine the effect of kelp harvesting upon fishes has been submitted to the United States Bureau of Fisheries. The observations were made between Point Loma and La Jolla, in the vicinity of San Diego, California. Evidence of the presence of fish eggs on the kelp was sought. In the case of harvesters that grind the kelp as it is cut such evidence, of course, is not available; but some harvesters do not grind the kelp while cutting it, and in such cases the opportunity was afforded for making the desired observations. No evidence of eggs, fish, or crawfish larvæ could be found. On the kelp beds the leaves were examined to a depth of 8 or 10 ft., and the specimens of molluscs, crustaceans, worms, hydroids, etc., collected. Some small fish were taken, but these were not the young of fish suitable for food, since they were mature at 1 in. in length. No fish eggs could be found.

Although three harvesters had been working on this bed for more than three months, the amount of kelp at the surface of the water had not decreased appreciably. It is said that if the harvesters begin at one side of the kelp beds and cut clean as they go, the first part will have grown again to its natural condition before the whole bed has been passed over.

While the preliminary observations in this region afforded no ground for suspecting that the harvesting of kelp is injurious to important fish or shell-fish, the Bureau intends to continue the investigation.

CUTCH PRODUCTION IN BURMA.

The demand in the United States for crude dyes is being met, in part, by increased shipments of cutch from Burma. In 1915, 1,234,140 lb. of cutch were exported, in contrast with 237,440 lb. in 1914.

In the manufacture of cutch no scientific process is employed, the industry being carried on exclusively by natives. It is obtained from the *Acacia catechu*, the trees being felled while green, the bark taken off, and the timber chopped up and boiled in large cauldrons. The resultant liquid is drained off and solidifies as it cools. In the better qualities of cutch only the heart-wood of the tree is utilised.

It appears from a report by the United States Consul at Rangoon that cutch is brought to the market in several forms, the three principal ones being: (1) Tablets—small rectangular blocks weighing from 1 lb. to 2 lb.; (2) blocks—more or less square blocks weighing from 28 lb. to 56 lb.; (3) baskets—a soft cutch of a thick consistency, not so firmly congealed as the other two qualities. The quality differs in the three

forms in which cutch comes to the market. Tablet cutch is the best quality and basket cutch the lowest. Block and basket cutch usually contain more impurities than tablet cutch, but in recent years a larger business has been done in basket quality than in the other two, probably because basket is the cheapest of the three. On arrival in Rangoon the cutch is packed in wooden cases (usually containing 1 cwt. net) and is then ready for export.

Cutch trees are found throughout the whole of Burma, but the question of transportation makes cutch-boiling unprofitable in many districts. Licences for cutch manufacture are granted annually by the Government, and the industry is more or less of a stand-by to the population in seasons of bad harvests. The Burmese Government increases or reduces the number of licences as necessity indicates. The principal producing districts in Burma are Prome, Thayetmyo, Myingyan, Minbu, Pegu, Yamethin, and Pyinmana.

Cutch is used largely as a dye, but in addition to this it is employed in some countries for tanning and as a preservative. In Burma fishing nets and sails are steeped in it to preserve them from the action of sea-water.

IRON ORE IN SIBERIA.

The iron deposits in the basin of the River Telbess, right tributary of the River Konduma, flowing into Tom River, opposite the city of Kuznetsk, Siberia, have been known since the last century, but not until recently was the region surveyed. In 1913, according to a report by the United States Consul at Vladivostock, the region was turned over by the Crown Land Administration to the Kuznetsk Coal Mine Joint Stock Company, which undertook a careful study of the district with the view of establishing a large iron foundry and works.

Professor P. P. Gudkoff was engaged to do the work, and some of the results are already published. Over ten independent iron deposits were discovered in the region. The main deposit is situated on the right bank of the Telbess River, some five miles from its influx into the Konduma River. It is of an eruptive nature, and consists mainly of granodiorite, quartz, porphyrites, and melaphyre, with secondary strata of crystalline limestone, hornblende, slate, etc. The normal sedimentary strata were discovered only to the north of the region, where the Telbess iron region is separated from the Kuznetsk coal region.

The volume of ore uncovered at the Telbess deposit proper amounts to 3,611,412 tons of 58 per cent. ore and 3,069,700 tons of poorer ore, and at the so-called Temir-Tau deposit to 7,222,824 tons of 54 per cent. ore and 1,305,706 tons of poorer ore. Studies of other deposits of the region in 1915 indicate that the total deposit amounts to over 27,000,000 tons of ore.

THE MARODEM OR VEGETABLE WOOL OF HAYTI.

There are two varieties of kapok fibres to be found in Hayti, both products of trees of the Eriodendron family and both of good quality. The local names for the fibre vary according to the locality; "marodem," "cotton mapou," and "cotton noir" are those most commonly used.

Kapok is fairly abundant all over Hayti, but no commercial use has been made of it. The natives sometimes stuff pillows with it, and occasionally mattresses, but this is about the extent of its utilisation. Indeed, all over the West Indies it is little used and has no fixed market value, except in Cuba, where it is a well-defined article of local trade, and where considerable quantities are bought from the Dominican Republic.

In a report calling attention to this fibre, a special agent of the United States Department of Commerce says that of late some interest in this substance has been taken in the United States, and it is being advertised under fancy trade names as a new discovery for life preservers, cushions on steamers, pillows, and the like. As filling for mattresses it is stated to be an ideal substance, being exceedingly light, absolutely sanitary, and possessing such resilience that even after long use it does not lump or pack. As a quilting material for bed coverings it equals wool in warmth and excels cotton in softness and lightness. For dressing gowns, smoking jackets, and other padded garments it has much to recommend it. For upholstery it is superior to most materials now in use.

Kapok is used in England to some extent in the manufacture of hats, and certain of the longer varieties are mixed with cotton to impart a silky lustre to fabrics. The regular kapok, however, has too short a fibre to spin. It is extremely inflammable, and this is its chief drawback. If the fibre could be so treated with chemicals as to eliminate this dangerous quality it would be very much more valuable.

OBITUARY.

Frank Debenham.—Mr. Frank Debenham died at his residence in Hampstead on January 15th, in his eightieth year.

He was the son of Mr. William Debenham, whom he succeeded in the firm of Messrs. Debenham and Freebody. He was chairman of Debenhams (Limited) from 1905 to 1912, and remained a director till 1914, when he retired.

For many years he took an active interest in municipal affairs. He stood as Progressive candidate for West Marylebone at the first County Council election. He was defeated on that occasion, but in 1889 he was appointed by the Council to represent the borough as Alderman, and he retained his seat for six years. He also

stood as Liberal candidate for Cheltenham in 1892, but was defeated. He served on the board of management of Middlesex Hospital, was a director of the Westminster Life Assurance, and till his death remained a director of Y. Redmond et Cie, of Paris.

He was elected a member of the Royal Society of Arts in 1888, and occasionally took part in the discussions.

Colonel Frank Griffith, V.D.—Colonel Frank Griffith, of the firm of Messrs. W. P. Griffith & Sons, Ltd., printers, of Prujean Square, Old Bailey, died on January 4th at the age of fifty-five. For many years he commanded the 2nd Kent Volunteer Artillery, now known as the 4th London (Howitzer) Brigade, Royal Field Artillery, and he contracted pneumonia whilst on duty as second in command at Biscot Camp, Luton. He was a former Mayor of Bromley, where he lived; Chairman of the Catford Conservative Club; and President of the Kent County Football Association. He was elected a member of the Royal Society of Arts in 1892.

NOTES ON BOOKS.

A Naturalist in Borneo. By the late Robert W. C. Shelford, M.A. Edited with a biographical introduction by Edward B. Poulton, D.Sc., LL.D., F.R.S. London: T. Fisher Unwin. 15*s*.

The tubercular hip-joint which compelled young Shelford to spend many years lying on his back, and deprived him of the ordinary sports and pastimes of boyhood, developed in him a faculty of close observation of nature, which in later years, when health had been in considerable measure restored to him, he turned to good account. On leaving Cambridge, where he took both parts of the Natural Sciences Tripos, he spent two years as Demonstrator in Biology at the Yorkshire College, Leeds, and in 1897 he went to Borneo as Curator of the Sarawak Museum, established by Rajah Brooke at Kuching. Borneo is, of course, one of the happiest hunting grounds for the naturalist; and in the seven years which he spent there Shelford devoted himself enthusiastically to the study of tropical life. On returning to England in 1905 he was appointed Assistant Curator in the Hope Department of Zoology in the University Museum at Oxford; here he worked assiduously until 1909, when his former trouble broke out again, and led, after much suffering, to his early death in 1912. During his long illness he spent much time in preparing the notes which he had made of his work in Borneo. Unfortunately, the painful nature of his illness did not give him opportunity to complete the task, which was left in very considerable confusion; but the great skill and care with which Professor Poulton has edited these remains—although naturally they cannot hide the somewhat fragmentary nature of the volume—have given to us a work of original and remarkable interest.

Among the mammals of Borneo, no doubt the most interesting is the orang-utan, which is still plentiful in Sarawak, though very local in its distribution, being found only up the Simunjan, Balang Lupar, and Rejang Rivers. It is an extremely difficult creature to study, for it is essentially arboreal in its habits, and it moves rapidly along the higher branches of the trees, while the would-be observer can make little or no headway through the thick tropical undergrowth. The author contrived, however, to learn something of the orang's habits, both from wild specimens and from a young one which he kept as a pet for many months, and which he found "cleanly, affectionate, extremely intelligent and amusing." A remarkable photograph of an orang's "nest," or sleeping platform, is given. Little larger than a rook's nest, it is placed among the slender boughs near the top of a moderate-sized tree. The beast "lies flat on its back on its nest, and holds like grim death with hands and feet to the branches in the fork of which the nest lies; and so it passes the night, half supported by the frail platform, half suspended by the hands and feet, whose grip is secure even in the deepest slumber." It will be remembered that when the orang "Sally" escaped from her cage in the Zoological Gardens, Regent's Park, her first instinct was to make herself a "nest" in a neighbouring tree.

Two other interesting monkeys of Borneo are the pig-tailed macaque (*Macacus nemestrinus*), which is trained by the Malays to pick coconuts for its masters; and the crab-eating macaque (*Macacus cynomolgus*), which moves about in family groups, and is so co-operative in its habits that "in cases of difficult parturition the other females act as accoucheuses, with sometimes disastrous results to the baby." A couple of photographs taken by the author of the Bornean lemur (*Tarsius spectrum*) deserve notice, as the animal is very little known even among naturalists, no specimen having ever reached a European menagerie.

The birds, reptiles, and insects of Borneo, of course, provide wonderful material for the field naturalist, and Mr. Shelford's chapters on these subjects will be read with much interest. They are followed by a section on mimicry, of which the author takes a wise and moderate view, and by three or four miscellaneous chapters dealing with various anthropological questions.

GENERAL NOTES.

THE SUEZ CANAL.—According to a White Paper giving returns of the shipping and tonnage of the Suez Canal, the net tonnage for 1915 shows a decrease of 4,143,340 tons as compared with 1914, and a decrease of 4,767,729 tons as compared with that of 1913. The reduction of the transit dues to f.6.25 per ton from January 1st, 1913, together with the reduction of tonnage, had the effect of reducing the gross receipts, which amounted in 1915 to f.93,522,616, as compared with f.122,248,853 in 1914 and f.126,650,934 in 1913. The increase of 50 centimes per ton in the transit dues, which came into effect on April 1st, 1916, is expected to compensate partly for the reduction in the receipts caused by the decreased tonnage. The number of vessels which passed through the Canal was 5,085 in 1913, 4,802 in 1914, and 3,708 in 1915, of which 2,951 in 1913, 3,078 in 1914, and 2,736 in 1915 carried the British flag. There was a decrease of 1,254,240 tons in 1915 as compared with 1914 in the tonnage of British vessels, which amounted to 12,052,484 tons in 1913, 12,910,278 tons in 1914, and 11,656,038 tons in 1915. During the same period the tonnage of German vessels decreased from 3,352,287 tons in 1913 to 2,118,946 tons in 1914, and disappeared entirely in 1915. The percentage of British vessels and their net tonnage in 1915 was 73·8 and 76·3 respectively, against 64·1 and 66·5 in 1914 and 58 and 60·2 in 1913. The number of troops carried through the Canal in 1915 was 119,812 as against 228,720 in 1914, being a decrease of 108,908. There was an increase of 715 French, 143 Dutch, and 61 Belgian, against a decrease of 82,969 British, 14,782 Turkish, 6,075 German, 5,999 Italian, and 2 Spanish as compared with 1914. The number of civilian passengers was 86,653 in 1915 against 155,183 in the preceding year, being a decrease of 68,530; while the number of pilgrims, emigrants, and convicts was 4,065 in 1915 compared with 7,869 in 1914, or a decrease of 3,804. In the year 1870 only 26,758 civil and military passengers were carried through the Canal. The mean duration of passage for all vessels navigating the Canal during 1915 was 17 hours 58 minutes.

PURIFICATION OF WATER BY ULTRA-VIOLET RAYS.—River water is filtered, refrigerated and sterilised, then circulated through 12,000 ft. of 1-in. galvanised pipe to thirty-five sanitary drinking fountains in the plant of the Atlas Portland Cement Company at Hannibal, Missouri, by a supply system recently installed at an expense less than the old system of supplying the workmen with cooled water in barrels. The refrigerating plant consists of a 7½ in. by 7½ in. two-cylinder, vertical single-acting, enclosed, self-oiling, 12-ton York ammonia compressor, driven by a variable-speed 20 h.p. motor and a Shipley double-pipe, flooded condenser. The cooling tank contains 1,200 ft. of 1¼-in. pipe in expansion coils. Besides refrigerating the drinking water, the plant freezes 600 lb. of ice daily for use around the plant. The 12,000 ft. of pipe through which the water is circulated is broken up into loops through which the refrigerated water is pumped. The longest of these loops contains about 5,000 ft. of pipe. Most of the pipe is laid 3 ft. under the ground, with no other insulation than the clay, the piping above the ground being covered with a cork lagging. Fifteen hundred gallons of water are circulated per hour, leaving the pump at an average temperature of 40° F. and returning to the cooling tank at temperatures fluctuating between 50° F. and 55° F. Thus a fairly uniform temperature is obtained at the fountains, varying between 40° F. and 50° F. according to their location in the several loops. The sterilisation of the water is one of the unique features of the installation. The apparatus, known as a RUV steriliser, utilises the ultra-violet ray as produced by a special mercury-vapour lamp sending its rays into the water through a quartz tube. The new drinking-water system reduced the expense and trouble connected with supplying the workmen with water and ice in barrels, at the same time giving the employees the benefit of a drinking water that is both pure and cold.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

JANUARY 24.—W. A. M. GOODE, Hon. Secretary, National Committee for Relief in Belgium, "Relief Work in Belgium."

JANUARY 31.—MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France."

FEBRUARY 7.—ROBERT FORTESCUE FOX, M.D., "The Future of British Spas." SIR THOMAS BARLOW, Bt., K.C.V.O., F.R.C.P., M.D., LL.D., F.R.S., will preside.

FEBRUARY 14.—LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Byways."

FEBRUARY 21.—MRS. C. HOSTER, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment."

FEBRUARY 28.—FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

MARCH 7.—JAMES HARRIS VICKERY, LL.B., "German Business Methods."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

FEBRUARY 15.—PROFESSOR H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S., Imperial College

of Science and Technology, "The Indian Silk Industry." The RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

MARCH 15.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

APRIL 19.—D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

MAY 17.—SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

JANUARY 30.—OCTAVIUS C. BEALE, Representative and Past President of the Australian Associated Chambers of Manufacture, "Imperial Industries after the War." The RIGHT HON. WALTER H. LONG, P.C., LL.D., F.R.S., M.P., Secretary of State for the Colonies, will preside.

FEBRUARY 27. — ALFRED BIGLAND, M.P., "Imperial Assets and how to use them."

MARCH 27.—The HON. FREDERICK W. YOUNG, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced :—

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

DR. M. HORN, "The Belgian Colonies."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

January 29, February 5, 12, 19.

HOWARD LECTURES.

Monday afternoons, at 5 p.m. :—

WILLIAM RIPPER, D.Eng., D.Sc., Professor of Engineering, University of Sheffield, "Works Organisation and Efficiency." Three Lectures.

April 23, 30, May 7.

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m. :—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 5, 12, 19.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JANUARY 23...Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Old Brain and the New Brain." (Lecture II.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. F. J. Waring, "On the Physical Features of 'Adam's Bridge,' and the Currents across it, considered as affecting the Proposed Construction of a Railway connecting India with Ceylon."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Messrs. D. E. Benson, W. B. Ferguson, and F. F. Renwick, "A Simple Form of Accurate Density-Measuring Apparatus."

Colonial Institute, Caxton Hall, Westminster, S.W., 4 p.m. Mr. A. W. Gattie, "Goods Transport Reform at Home and Overseas."

WEDNESDAY, JANUARY 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. W. A. M. Goode, "Relief Work in Belgium."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. Mary Scharlieb, "The Prevention and Arrest of Venereal Disease in Women."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Rev. M. Summers, "A Great Mistress of Romance: Ann Radcliffe (1764-1823)."

THURSDAY, JANUARY 25...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir Walter Raleigh, "The Strength and Weakness of Romantic Poetry." (Lecture II.)

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Mr. C. R. Peers, "The Care of Ancient Monuments."

FRIDAY, JANUARY 26...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. P. Norman, "Queen Square, Bloomsbury."

Royal Institution, Albemarle-street, W., 5.30 p.m. Professor G. Murray, "Epicurean Philosophy."

University of London, University College, Gower-street, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture II.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, JANUARY 27...Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. R. Hinks, "The Lakes and Mountains of Central Africa." (Lecture II.)

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Journal of the Royal Society of Arts.

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FRIDAY, JANUARY 26, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICE.

NEXT WEEK.

MONDAY, JANUARY 29th, at 4.30 p.m. (Cantor Lecture.) PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." (Lecture I.)

TUESDAY, JANUARY 30th, at 4.30 p.m. (Colonial Section.) OCTAVIUS C. BEALE, Representative and Past President of the Australian Chambers of Manufacture, "Imperial Industries after the War." The RIGHT HON. WALTER H. LONG, P.C., LL.D., F.R.S., M.P., Secretary of State for the Colonies, will preside.

WEDNESDAY, JANUARY 31st, at 4.30 p.m. (Ordinary Meeting.) MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France." COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

WEDNESDAY, JANUARY 24th, 1917; MR. A. SHIRLEY BENN, M.P., in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Beale, Lieut.-Colonel W., c/o Thomas Cook and Son, Ludgate-circus, E.C.

Blades, Alfred, Messrs. Blades, East and Blades, 23, Abchurch-lane, E.C.

Burnett-Hurst, Professor Alexander Robert, Sydenham College of Commerce and Economics, University of Bombay, Bombay, India.

Dreer, William F., 2121, Garden-street, Santa Barbara, California, U.S.A.

Hazard, Frederick Rowland, Syracuse, New York, U.S.A.

Islington, The Right Hon. Lord, P.C., G.C.M.G., D.S.O., 8, Chesterfield-gardens, W.

Krishna, Siri, M.A., Ludhiana Ice Factory, Ludhiana, Punjab, India.

Kumar, Hukm Chand, B.A., D.A.V. High School, Quetta, Baluchistan, India.

McCrone, Robert, Haughbank House, Mauchline, Ayrshire, N.B.

Mackenzie, Lady Owen, 6, Chesham-street, S.W.

Ong Boon Tat, 29, South Canal-road, Singapore, Straits Settlements.

Reid, Sir Marshall Frederick, C.I.E., Woodcote Lodge, Epsom, Surrey.

Ring, John, 508, Merchants' Exchange, St. Louis, Missouri, U.S.A.

Schuster, Professor Arthur, D.Sc., F.R.S., Yeldall, Twyford, Berks.

Sethi, Seth Mauckchand B. (Tazr-ul-Mulk), Gwalior, India.

Sheppard, William Didsbury, C.I.E., East India United Service Club, 16, St. James's-square, S.W.

Tabor, Frederick Richard, 3, Duke-street, Adelphi W.C.

Tilston, Henry Edward, M.I.N.A., Calle Cangallo 499, Buenos Aires, Argentina, South America.

Waterlow, Edgar L., Messrs. Waterlow and Sons, Ltd., Great Winchester-street, E.C.

Wigglesworth, Edwin, 9, Carlton Mansions, Holland Park-gardens, W.

THE CHAIRMAN, in introducing Mr. Goode, the reader of the paper, said that everyone recognised how difficult the work of relieving Belgium was, and how absolutely necessary it was that it should continue. It had been carried on in a very remarkable and thorough manner by the Neutral Commission, with whose work Mr. Goode, who was the Honorary Secretary of the National Committee for collecting funds in the British Empire for the relief of Belgium, was fully conversant.

The paper read was—

RELIEF WORK IN BELGIUM.

By W. A. M. Goode,

Hon. Secretary, National Committee for Relief in Belgium.

The work of saving life is so less dramatic than that of destroying it that the average public, quite naturally, knows little and apparently cares little as to why or how ten million Belgian and French citizens have been kept alive during the two years that Germany has occupied the territory they inhabit. The death in battle or by massacre—and the latter is a contingency perpetually to be guarded against—of 10 per cent. of these people would "stagger humanity" even in these times, and might be a crucial point in world history; but the outwardly prosaic task of protecting all of them and keeping them alive slips by comparatively unnoticed in the intimate tragedy of a war that brings a knock from death at the door of nearly every home. Yet this preservation of almost the whole of one nation, and of an appreciable part of another, constitutes an undertaking which, in scope and complexity, can only be compared to the war itself. And I may as well say at the outset that, knowing my own limitations, I despair of doing justice to the undertaking or to those who undertook it. I would also like to add that, until the war is over, there are phases of the affair—phases that present themselves to almost every thinking mind—that must be left unexplained or only partly cleared up, because our attitude toward the enemy and our relations with our Allies and neutral powers are constantly being involved by the conduct of this Belgian relief.

At the risk of boring those who have watched and loyally helped the work, I must first of all remind you how relief in Belgium came to be necessary, and how it was instituted. The invasion of Belgium began on August 4th, 1914, and by October 15th of the same year the Germans held practically the whole country, with seven and a half million Belgians as captives. The Germans, quoting the Hague Convention, which seems almost super-Biblical in the elasticity of its interpretation, declared that it was the duty of the occupied country to maintain the occupying army, and that if scarcity arose it must be attributed to the blockade of Belgian ports by the Allied navies. Conquest and requisition had destroyed supplies and paralysed industry, with the result that a country which in time of peace was compelled to import three-quarters of its food supply found itself threatened with famine.

The question, many times, and with excellent reason, is asked: "If we had not relieved Belgium, would not Germany have been, in the last resort, compelled to feed the people?" The best answer to that lies in what actually happened in Belgium in the early days of October, 1914. In Charleroi the Germans compelled the municipal authorities to provide the bread necessary for the occupying troops. In reply to the burgomaster's protest that this would leave at least ten thousand inhabitants without the basis on which to sustain life, the burgomaster was told that that was no concern of the conquerors — it was the fault of the Allies. Exactly the same demands, with the same results, occurred at Liége and other centres, while in Brussels, Antwerp, and similar thickly populated cities, destitution automatically increased with such leaps and bounds that the seriousness of the problem quickly became apparent. Every scrap of evidence I have been able to gather—and I personally took down the burgomaster of Charleroi's statement when he came in haste to England early in October to beg for food to save his people, besides seeing many other credible witnesses and having access to all the official documents—convinces me that the Germans would at that time have been guilty of the crime of deliberately allowing the people in Belgium to reach such a stage of starvation as to compel them to riot, and thus give pretext for wholesale massacre of unarmed civilians by armed troops, while those who survived would have been decimated by disease due to underfeeding. It may be said that this is hypothesis, and that the initial action of the German occupying army was only meant to overawe the population and bluff the Allies into eventual feeding of the people. My answer is, that in every known instance the Germans enforced their requisitions for food regardless as to whether or not their fulfilment involved immediate or threatened starvation; that they then and ever since have maintained that, in principle, the Allies were directly responsible through their blockade for any deaths that in consequence occurred; and that, subsequently, in Poland, while Polish potatoes were being sent to Switzerland, thousands of Poles actually starved to death because the Germans refused to feed them. There are some who say that what the Germans did in Poland is, in itself, convincing proof of what would actually have happened in Belgium; but I should prefer to put it more cautiously.

namely, that every act of Germany in accomplishing the conquest of Belgium definitely indicated that no mercy could be expected by the civilian population, and that our loyalty to an allied people—apart from any consideration of humanity, and apart from the lowest material reason of endeavouring to retain their allegiance while in captivity—inevitably dictated to us such a policy as was calculated to nullify Germany's preliminaries to starvation, and that we were not justified in regarding those preliminaries as a bluff. You cannot gamble with the lives of over seven million defenceless people when your only trump card is a belief that Germany will not descend to the depths of inhumanity.

This view was certainly shared by the United States Minister who remained in Brussels, by members of the American community, and by the Belgians themselves. An American-Belgian Committee had been formed in Brussels to alleviate the local destitution. As the magnitude of the problem dawned, and as the German attitude became more sharply defined, Mr. Millard Shaler, an American engineer, came to London, on behalf of the Brussels Committee, to secure the co-operation of his fellow-countrymen. There followed an urgent message from the American Minister in Brussels to Ambassador Page in London, asking for measures to be taken to avert famine, and also appeals from Charleroi and other centres.

These conditions led up to the formation of the Neutral Commission for Relief in Belgium. I make no excuse for taking up so much of your valuable time in recapitulating the preliminaries, because I feel sure that for years to come historical and military controversy will centre around the hypothesis as to what really would have happened if the seven and a half million Belgians in Belgium had been left entirely at the mercy of Germany.

As no great movement, justly or unjustly, can be dissociated from the personality of its leader, titular or otherwise, I am here compelled to speak of the man for whom the American Ambassador in London sent when he received the call for help. I say "compelled," because Mr. Herbert Hoover is aggressively averse to anything being said about himself when so much must be left unsaid about relief in Belgium. And yet, with the certainty of being rebuked, I record the opinion, quite impersonally and dispassionately, that without Mr. Hoover we should long ago have been unable to continue to relieve Belgium. Mr. Hoover is an eminent American engineer. On the outbreak of war he formed a committee in London to help the thousands of Americans who were suddenly stranded during their summer visit to our shores. So well did he do this that Ambassador Page, knowing also his world-wide experience in organisation and re-organisation, intuitively turned to him in October, 1914, and said: "Hoover, we've got most of our stranded Americans off; tell me what should we do about these appeals from Belgium?" If these were not the exact words, they, at any rate, represent the sense of an interview which has had incalculable effect.

The way I became connected with the work would be too ridiculously disproportionate for mention, except that it throws light on the character of the man responsible for it. The day after his interview with Ambassador Page, I went to see Mr. Hoover, by appointment, on a matter of ordinary business of some mutual importance. I waited an hour. Mr. Hoover came in, ordered a taxi, asked me to drive with him, and, totally ignoring what I had waited an hour to tell him, said: "I want you. We are trying to relieve Belgium." That same "I want you!" has brought to the aid of our Belgian Allies hundreds of Americans, who, with devoted self-sacrifice, have unostentatiously given their time, their money and their brains to the always difficult and often dangerous and sometimes thankless task of keeping alive a nation which our enemy threatened with extinction.

But I am anticipating. Mr. Hoover, with the co-operation of Ambassador Page, "overnight," so to speak, formed a committee of Americans in London and the United States to co-operate with their fellow-countrymen in Brussels. Diplomatic negotiations, with the strong support of President Wilson, were initiated for the recogn tion by the belligerents on both sides of a definite relief organisation, and meantime some immediate relief supplies were shipped. The Spanish Ambassador in London and the Spanish Minister in Brussels became, with their American diplomatic colleagues, patrons of the organisation, while at later dates the American Ambassadors in Berlin and Paris, the American Minister at the Hague, and the Netherlands Minister to Belgium also joined the Commission. A powerful committee was appointed in New York, and an appeal was issued by Mr. Hoover, with the approval of King Albert, to the American people, who responded with £1,000,000 within twelve months. A co-operating committee was

established in Brussels—the "Comité National" —a purely Belgian body, which included those leading bankers and business men who had remained, for mak ng arrangements as to the distribution of the relief.

That, in a very sketchy way, describes the genesis of the Neutral Commission for Relief in Belgium.

In March, 1915, at the request of French authorities, the Commission undertook to arrange for the feeding of the people in the occupied part of Northern France. At the end of April in 1915, the National Committee for Relief in Belgium, which I had the honour to organise, came into existence with the approval of His Majesty's Government. Its functions are to act as a central depository for all benevolent funds from the British Empire for the people in Belgium, and to issue appeals on their behalf. And while, with complete confidence, it remits all sums received to the Neutral Commission, it assumes no responsibility for the administration of those funds, except so far as it is authorised by His Majesty's Government, just as the Neutral Commission can have no responsibility for the necessarily un-neutral appeals and statements issued by the British National Committee.

To revert to the Neutral Commission. What in October, 1914, was an emergency committee, consisting of a few Americans in London and Brussels, acting as an ordinary charitable body, can now be described as one of the neutral powers in the war. Either directly or through its protecting ambassadors and ministers it has entered into extended and almost daily negotiations with the belligerent Governments, securing elaborate guarantees and arranging complicated agreements for none of which the world's diplomatic, political or military history provided precedent, any more than there was precedent for the existence of the Neutral Commission itself. There have been, I suspect, occasions when both belligerents, harassed into momentary irritation by internal and external crisis, would have liked to see the Commission for Relief in Belgium and its dogged chairman at the bottom of the sea; but these nerve-storms have almost invariably been succeeded by genuine admiration for the comprehensive grasp of the problem exhibited by Mr. Hoover and his colleagues, and for the "miracle of scientific organisation," to quote Lord Curzon, as presented by the self-sacrificing work of the Commission as a whole. I feel safe in adding that never during the war have the responsible heads of either the Allied or Enemy Governments ever for a moment doubted the strict neutrality of the Commission's acts. That, in itself, when tremendous issues hang upon the integrity and discretion of those who come and go with unequalled freedom between enemy countries, is a remarkable tribute. As to the devotion of the members of the Commission to the Belgian people, any outsider can draw his own conclusions regarding opinions likely to be held by American men of affairs who, without hope of reward and at great pecuniary sacrifice, gave up their occupations to serve as volunteers to save Belgium from the results of invasion.

To-day, thanks to the powers vested in it by the various belligerents, the Commission is practically responsible—with its co-operating organisation, the Belgian Comité National in Brussels and the Northern France Committee—for the entire feeding of about ten million people, of whom some 3½ millions in Belgium and 2 millions in France are totally destitute. Up to date it has expended on this work over £42,000,000. Of this amount some £5,000,000 has been contributed through the benevolence of the world, the balance representing subventions from the Belgian Government, supplied by the British and French Governments and by French institutions, with the notable addition of over £3,000,000, which is derived from profits made on the sale of food to those who could afford to pay for it. The Commission has already sent to Belgium and Northern France nearly three million tons of food, bought through its own voluntary branches in the world's primary markets and shipped by fifty or sixty cargo steamers, which week after week are employed to gather food from all quarters of the globe and to deliver it at Rotterdam. This unique merchant fleet sails under the Neutral Commission's own flag, is recognised by all the belligerents, and in itself would form the subject of a fascinating paper. Coincident with these amazing shipping and financial operations the American representatives of the Commission in Belgium, in conjunction with the Comité National and its 40,000 voluntary Belgian helpers, by an elaborate system which I will describe later, protect and personally supervise the distribution of all the food supplies until they reach those for whom they are intended.

This, I hope, has given a rough outline of how and why the relief work started, and what has been accomplished. As the problems connected with the Commission are complex, I ask your permission to deal with them under three

headings—viz., Political, Economic and Sociological, and Benevolent.

Political.

The one outstanding doubt, perpetually and rightly finding expression in public and private questions, is, "Does relief in Belgium help the enemy?"

Field-Marshal Lord French, in an interview published on the 3rd of this month, stated the best case I have seen as showing how the enemy benefits. Prefacing his remarks with the proviso that he spoke from the strictly *military* interests of the Allies, and was "leaving out of account all questions of humanity," our distinguished soldier declared that under the Hague Convention we had undoubted right to apply the blockade to Belgium after its occupation by Germany; that our decision to be humane had cost us over £22,000,000 in cash, besides seriously reducing the merchant tonnage so badly needed for our own food supplies; that the Germans had taken large amounts of home-grown live-stock and foodstuffs from Belgium, to say nothing of their seizures of raw material and machinery, or of their financial robbery by imposing on Belgium an indemnity that amounted to £100,000,000. Lord French concluded: "The indirect cost to the Allies has been that of relieving the Germans of all responsibility for the maintenance of over 7,000,000 people, whom, under international law, they were obliged to feed and maintain in health, and whom, moreover, they otherwise actually would have had either to feed or to deport wholesale, since it is impossible, from a military point of view, to have a starving population on the lines of communication of a great army."

All of which, to the casual reader, would give the impression that the sooner we stopped relieving Belgium the better for ourselves. Lord French, of course, committed himself to no such conclusion, and it seems to me a pity that his excellent summary of all the military advantages we have sacrificed in loyalty to our Belgian Allies and in the name of humanity was not accompanied by an expression of the opinion, which I believe he holds, that we adopted the only course consistent with our national honour, and that we should not swerve from it. The *Daily Telegraph*, commenting upon Lord French's statement, said, editorially:—

"Are these acts regretted by the British people? The question has only to be asked to answer itself, even though the enemy has thereby been strengthened economically at our expense and, at the same time, enabled to squeeze out of these miserable people forced contributions which must amount to not less than £100,000,000. The British policy towards Belgium, as towards neutrals, has been the very opposite of that adopted with merciless cruelty by the Germans. It is a mistake in war to take short views."

By a curious paradox, Count von Reventlow and other German military authorities have been publicly and privately agitating against allowing further relief supplies to go into Belgium. They maintain that but for the action of the Neutral Commission the civilian population in Belgium, or what was left of it, would by this time have succumbed to German pressure and German suasion, and that, to all intents, Belgium would have been a liege province of Germany. Basing, as Lord French also does, their arguments on purely military grounds, they declare that Belgian man-power could long ago have been starved into working except for the ration received from the Allies through the Commission, whereby they were enabled to maintain what will always be known as the greatest passive resistance in history. These German authorities insist that their Government have blundered, that the deportations of Belgian labour have come too late in the day to get good work out of men whose bodies and spirits have been so sustained that, despite two years of captivity, they could not be compelled to accept high wages, even at the point of the bayonet.

The historian of the war, with all the facts at his disposal, will probably find that both Lord French and Count von Reventlow had a good deal to justify their diametrically opposite views of the same military situation. Without entering into a further discussion on this point, and without touching upon the obvious and paramount question as to what would be the attitude of the Belgian Government if we left nine-tenths of the Belgian nation at the complete mercy of the Germans, I will read you the considered opinion of a distinguished member of the present Government, Mr. Walter Long, the Secretary of State for the Colonies, whose stalwart patriotism has never been questioned. Mr. Long wrote to the National Committee for Relief in Belgium, on the 2nd of this month, as follows:—

"It is obviously impossible to guarantee that no relief or advantage is derived by the enemy from the assistance given to those who suffer under their iron heel; but, on the other hand,

it is impossible to exaggerate the advantages which must accrue to the cause of the Allies by the work which is now being done for the relief of the unfortunate people who are bearing so courageously the bitter persecution of the Germans. There can be no doubt that this good work will bear fruit not only to-day, but in the future, when we come to the resettlement of boundaries and the relations between the different countries."

You will notice that, like Lord French, the Colonial Secretary excludes the humanitarian aspect; but, after taking into consideration the military view, he arrives at such a conclusion as may be expected of statesmanship. And in the opinion of the British National Committee the policy he enunciates, and the reasons he adduces for it, are incontrovertible. Speaking solely upon the humane phase of the problem, the same Minister expressed the opinion that if we now left the people in Belgium to subsist on what they could get from Germany, it would be the "blackest page in our national history."

It is essential to remember that the determination of our present Government to continue to relieve Belgium, and all the activities of the National Committee in furthering that policy, are only resultant upon searching investigations as to the precautions taken to safeguard the food supplies sent into Belgium. If it were not for the confident belief that every measure humanly possible was employed to prevent leakages to the enemy there might, in my opinion, be justification for the Government in reconsidering their policy of relief, with consequent cessation of our work as a national body. The nature of the precautionary measures employed I will deal with in a moment; but, in passing, I may say that those who have had these investigations in hand, and who have come into personal contact with Mr. Hoover, all share, not only a high appreciation of his transparent integrity, but a belief, based upon experience, that his pertinacity and fearlessness, backed up by the moral influence of the American and Spanish Governments, are a compelling force in making the Germans observe, at any rate to a degree scarcely to be expected, their guarantees. Otherwise he would not have been able to exact even such partial reparation as has been made in response to Allied protests against breaches in food agreements.

These agreements and their breaches are the cause of constant and trying negotiations between the Neutral Commission and the belligerent Powers. Two outstanding factors in connection with them should always be borne in mind. The first is that the leakages in food supplies cannot be *comparatively* appreciable, otherwise the people in Belgium would not be alive to-day, because only enough food has been allowed into Belgium through our blockade to provide a bare living ration. That ration, including the native supply, represents only 1,900 calories per capita per diem. The minimum considered necessary to maintain life and carry on light work is 2,400 calories. The average consumption per capita in the United Kingdom is about 4,000 assimilated calories. The second factor is that practically every one of the seven and a half million Belgians in Belgium is a spy, and rightly so, upon whatever the relentless invaders may do in connection with the relief supplies. Apart from the guarantees, and the American supervision, and the 40,000 educated Belgians engaged in distributing the food, every man, woman and child in Belgium is only too glad of the opportunity to tell of cases where food, which they know is intended for themselves, is taken by a German soldier.

The system enforced by the Neutral Commission for safeguarding the relief provided for Belgium by the Allied Governments and the benevolence of the world is, roughly, as follows:—

At Rotterdam, all food supplies consigned to the Commission are reloaded into canal boats or, in small proportion, into railway trucks. They are then sent under seal of the Commission to the terminal warehouses in Belgium, and thence reissued to 4,657 communal warehouses. The Rotterdam office charges each communal committee through provincial and regional committees with the amount of its consignment, and each commune has to pay, either in paper currency or in receipts from the destitute, for the amount of food received. It is obvious that the communes would not acknowledge their indebtedness unless they received their consignments in full, and the books of the Commission, which are audited in Brussels by representatives of the American house of Deloitte, Plender & Griffiths, show that there is no discrepancy as between the amounts shipped from Rotterdam and the amounts receipted for by the communes. From each communal warehouse the food supplies are issued direct to individuals under a card system, which I shall describe when I come to the economic and sociological section of this paper.

As a further precaution, the Commission have established at Brussels a bureau of statistics, whose sole business it is to verify the issues of

food from the communal warehouses with the returns which each commune is compelled to make of the rations they distribute to individuals. Not satisfied with this, the Commission maintain in every province another bureau of inspection and control, composed of Americans and Belgians, and over these bureaux there is a central control bureau in Brussels. Each of these bureaux has a force of inspectors whose constant occupation is to go from one commune to another to report upon the organisation and to investigate any complaints. As the final link in this chain of precautions, a staff of prosecutors is available to bring to justice any of those who may violate the guarantees or infringe the local regulations.

No system is perfect, and even with these minute safeguards the Germans break the spirit of the agreements; but the precautions taken fortunately assure that such breaches cannot do the enemy much good. When one also realises that before the Commission is allowed to take through our blockade a single ton of food the actual necessity for it has to be established to the satisfaction of our own Admiralty and war trade experts, there does not seem to be any loophole that has not been closed, so far as loopholes can be closed while an enemy holds captive ten million of our civilian Allies whom, in honour, we are bound to succour.

I should not be surprised if the principal political difficulty which the Neutral Commission have to face were their relations with the German authorities; but, as I am looking at Belgian relief through British eyes, I have intentionally confined this section of the paper solely to that phase which is all-important to the Allies.

Economic and Sociological.

The rationing of ten million people, not only in a state of industrial collapse, but ruled and isolated from the rest of the world by a hostile race, has naturally been an experiment replete with lessons invaluable to the economist and fascinating to the sociologist. Indeed, I am almost inclined to think, especially in view of our own immediate food problems, that it might have been wiser had I devoted the whole of this paper to the experiences and conclusions of those who planned and are now carrying out this unprecedented adventure in food distribution and control. I am permitted to quote a few excerpts from an invaluable memorandum drawn up by one who has fought out on the spot all those difficulties which, late in the day, we are now tackling for ourselves.

"The objective of any food control," he writes, "must be simply the tempering of consumption to necessity of supply, and its just distribution over the whole population." Dealing with the *repression* of food consumption by enforcing the maximum quantities that the consumer may purchase by the issue of household cards, he comments as follows:—

"It is worth bearing in mind that the success of the Belgian relief and the failure of the German system have been due to the intense decentralisation of the Belgian relief and the intense centralisation of the Germans. Decentralisation is the absolute keystone of executive success in any stage of individual rationing enforcement.

"In Belgium the relief has a central organisation which imposes general regulations and delegates the entire execution to 'provincial' volunteer committees. These committees again legislate for the provinces in expansion of the central regulations to local needs (as each province varies in character of population—urban, industrial, agricultural). In this connection it has been found advisable to set up the larger cities as 'provinces.' The 'provincial' committees in turn delegate execution to local volunteer committees, who dominate populations of from 1,000 to 5,000 people. In some large provinces a series of 'regional' committees are injected between the 'provincial' and 'local' committees. The 'local' committees (as others) are made up of principal residents, embracing men of commercial experience and usually employing a small paid staff. These 'local' committees issue the household cards and employ inspectors for their enforcement, and attend to other control functions as they develop in necessity. A certain number of regular inspectors attached to the provincial committees must be imposed over the local committees.

"Such a structure thus furnishes an administrative foundation upon which much wider functions can be imposed than merely the household-card issue. In the United Kingdom the local authorities might be blended into such a system as the above, provided the units of population are not too large—as is the case in some parishes."

As to the repression by distribution of a ration through establishing Governmental stores and kitchens, which is the Belgian relief plan, my authority says:—

"In this case the whole of the controlled commodities are aggregated into central stores, redistributed into regional stores, from thence

to local district stores, and the actual ration issued from these newly created agencies. This plan also involves the establishment of public kitchens for making soup and stew with a view to obtain an effectual distribution of meat. By this means the whole of the normal commerce in the commodities thus controlled is obliterated. The plan, while a necessity to Belgium and Northern France, is totally infeasible in any country where it is necessary or desirable to maintain economic life. It is a plan only desirable of introduction in the last stage of national starvation.

"The price regulation is one of extreme difficulty. For commodities which are wholly imported from abroad, such as sugar, there is no great difficulty in fixing prices all along the reticulation line; also for commodities which are predominantly imported, such as cereals, it is possible for the State to fix the price and the remuneration to millers, brokers, and dealers. Moreover, where native commodities are controlled by the committee system, it is possible, in a great measure, to fix prices. Where supplies, however, fall below the demand, and where there is no control of the commodity distribution from the source, any attempts to fix prices have usually proved an entire failure. The whole experience in Belgium and Germany in such cases has been the extraordinary disappearance of a given commodity from the public markets w thin a short time after fixing the maximum price. The explanation appears to be that such maximum price is only necessary where there is an under-supply, and that with an under-supply the well-to-do members of the community gradually set up direct relations with producers and aggregate to themselves, not only their normal supply, but accumulate supplies as against the future, and these transactions take place outside the maximum price. This latter, however, would not apply if the country were closely decentralised and the local committees were sufficiently energetic in controlling the distribution of excess production of any given district to another, for by the control of licences to dealers to transfer from one district to another prices can be stipulated."

I am also indebted to Mr. Robinson Smith, an able American, who ungrudgingly served for fourteen months in Belgium as a delegate of the Commission, for a remarkably vivid illustration of the system at work. Perhaps I ought to preface my quotation, although it will be apparent to you as I read on, by the statement that Mr. Robinson Smith has strong leanings towards State Socialism. Describing the supply of bread to La Louvière, in the Province of Hainaut, Mr. Robinson Smith gives this comprehensive picture, to which I respectfully draw Lord Devonport's attention:—

"With our communism then, that is with the monopoly of the necessities of life which the Commission enjoyed in Belgium during the war, the hundred kilos of wheat are not bought in the open pit in Chicago in competition, but are bought by an official of the Produce Exchange on that day on which few orders are in, and when therefore he knows the price will drop. The hundred kilos of wheat are conveyed to New York at a special price; are loaded on a steamer by a shipping company which gives its agency services free; are conveyed across the Atlantic at cheaper than the prevailing rates, because the Commission, that is the State, is able to employ a fleet of its own; are paid for in lower than the average bankers' rates, because the London office of the Commission has ever an eye as to where exchange can be bought lowest, and so in one year saved 509,650 dollars (which is slightly more than its entire overhead expenses); are discharged at Rotterdam by a floating elevator (rented from the city of Antwerp) at a lower price and in a shorter time than had ever prevailed in the port of Rotterdam, because the Rotterdam office, under a Mr. Young, aged twenty-seven, and a Dutchman, Van der Sluis, of the same age, are filled with this spirit of service and ambition to excel; are loaded into a 300-ton barge and conveyed to La Louvière at a cheaper rate than from Antwerp to La Louvière, although the distance is twice as great, because the State has a fleet of barges under its own control, and can regulate to a nicety their continuous employ with no losses by the way; are paid for by the provincial committee of Hainaut cash at the Brussels office before the barge leaves Rotterdam; are ground in the mill at La Louvière at a minimum price, because the miller is assured of continuous work with no bad credit, free from the worry of competition, except in so far as he knows that he would lose the job if he did not produce a good flour; are turned over as flour to a baker of La Louvière who, having no other flour on his premises, which must be cleanly. must turn over to the town of La Louvière at its bread depot on the following morn one hundred and thirty-five kilos of bread, the most that a hundred kilos of flour will conveniently produce, having had no chance to sift his flour since he must turn all of it into bread, no chance to adulterate his flour since his premises are

open to inspection and his bread is subject to analysis, and, what is more important still, such a system of distribution of the bread established that he would automatically lose his trade, a danger to which he would not be exposed to the same extent at least in ordinary commerce, since many clients are tied to their tradesmen by habit, by credit, or by proximity of the shop; and a poor article is slow in turning them from him. He is paid by the commune 8 francs a hundred kilos for making the bread, about half of which is profit, and since even a small baker usually bakes several sacks a day, and since he also has a small trade in other things and is preserved from bad credit, he is contented with the new order of things, finds nothing to complain of in Socialism, although we have always been told that communal ownership would destroy the individual. The only bakers who objected in the Hainaut were the Socialist co-operative baking societies, who were afraid that the hold which they exercised upon the working population by their extensive credit and dangerous methods of premium and annuities would be taken from them. They were also afraid that they should be obliged to produce better bread, and they were.

"La Louvière, in some ways, was the last word in the system, since one bread depot there served twenty-five thousand people, the whole town, nor were there said to be ever more than ten people in the depot at one time. The test of any distributing food, clothing or money centre is the absence of a line of people in front of it; whenever one sees a line of people standing in the rain or sunshine, one may be sure that there is a defect somewhere in the scheme of relief.

"La Louvière was divided into six districts of four thousand persons or one thousand families each. The town record showed how many persons slept under each roof, and each roof received a corresponding ticket for bread. The figure was confirmed by the responsible head of the house, and on his door a short notice said that the provincial committee of Hainaut was feeding so many persons in this house. Thus there was no chance that, auntie having been there the month before, someone should still receive her bread for her. Not that the neighbours did report such abuses, but the head of the house knew that they would if he was guilty. You do not care for such inquisitorial methods. But neither do you care for riots and revolution, and the provincial committee had to choose between the two, and could only be sure that it was doing its duty if it availed itself of every possible chance of saving and protected itself against every possible chance of fraud. Its ideal was not at all that of disturbing as little as possible the habits of the people, trying to make them forget that it was war. On the contrary, it continually overrode the habits of the people rough-shod, and the people did not murmur, with the result that they had always plenty of bread to eat and no cake; whereas Vienna, for instance, where the other ideal prevailed, had two hundred and ten grammes of bread per person per day (instead of three hundred and thirty-five), and anyone that could pay for it had as much cake as he pleased.

"Section one at La Louvière, rich and poor alike, one from each family, called with the family bread card at the central bread depot on Mondays and Thursdays (morning), between nine and ten if their name began with A, B, C, etc.; ten and eleven, if F, G, H.; section two on Mondays and Thursdays (afternoon), and so on. They thus received their bread twice a week, which was often enough except in the summer time. The usual rule in the province was three times a week. The person, whether man, woman, child or servant, presented his bread card, which indicated not only the number of persons in the family, but by a rubber stamp of a certain colour indicated the number of loaves that he was to receive on that day. There was no checking off to be done on the depot book, but the card was to be punched on the day of distribution, the thirteenth, for instance, which was the same ideally all over the province. The card had ninety of these numbers printed upon it, and was good therefore for ninety days of distribution or forty-five weeks here at La Louvière. The very expensive method of delivering new slips every day at the house or hotel or of bread cards which were good only for two weeks, the method that prevailed in Germany and Austria, was thus avoided, and there was much less chance of abuse. The rules and regulations both for the commune, the baker and the inhabitant were printed on the bread card, and thus everyone knew what he had a right to expect. These rules and regulations said that the person, upon arriving at the bread depot, had the right to take the bread from the rack of the baker whom he chose. Every baker at La Louvière had a rack in this bread depot, and delivered a quantity of bread equal at first to the quantity consumed by his original clientèle, but which, in the first weeks, varied according as from a comparison of

the appearance of the bread upon the racks or from a knowledge of the quality of the different breads when eaten, people, uninfluenced now by questions of propinquity or credit, freely chose the best bread. These quantities to be delivered by the baker soon became constant because automatically every baker baked as well as he knew how when he saw the danger to which poor bread was subject. Here one sees that this kind of Socialism employed competition, and competition unhampered by the usual hindrances that it meets with in trade."

The system, so interestingly illustrated by Mr. Robinson Smith, applies, with necessary variation, to the handling of bacon, lard, rice, soap, and so forth.

If Mr. Hoover were asked what his views were as to Belgian relief being a contribution to State Socialism, he would certainly say "Nothing whatever," on the grounds that, while one may command without payment or hope of reward the skill of the world over a period of emotion and devotion—such as the 40,000 volunteers from the Belgian intellectual classes connected with the relief organisation—neither these volunteers nor this devotion are possible as a constant human instrument.

Benevolence.

In accepting the invitation to read a paper before this Royal Society I thought I could best show appreciation of the compliment by confining myself mainly to the international and economic phases of Belgian relief, rather than by an endeavour to press home the appeal to charity which was inaugurated by His Majesty the King, and recently has been eloquently voiced by the Lord Mayor of London and by the religious and political leaders of our nation.

I will therefore endeavour to dismiss this part of the paper quite briefly. The benevolent account of the Neutral Commission shows an expenditure in Belgium up to October 31st, 1916, of over £26,000,000. This has been rendered necessary by the inability of over 3,500,000 of the 7,500,000 people in Belgium to pay for supplies. Towards this amount the public of the world had subscribed, up to the same date, only £4,940,038, and of this nearly £3,000,000 had been contributed from the British Empire. I may, perhaps, be pardoned for saying here that in twenty months the National Committee for Relief in Belgium have obtained solely from British sources over £2,150,000, or an average of £107,000 per month. The remainder comes mostly from generous sympathisers in the United States.

The ever-rising cost of food and shipping, combined with the alarming increase in destitution, render it difficult, if not impossible, for the Neutral Commission, even with larger Government subventions and with their wonderfully contrived profits, to make both ends meet. The increase in destitution is due in no little degree to Germany's refusal to permit the resumption of manufactures in Belgium, except on terms to which it would be suicidal for the Allies to agree, and to her inhuman deportations of partially or wholly employed men, thus throwing more women and children on the bread line. In reference to the Commission's "profits," I should like to explain that while these were made on commodities sold to those who could still afford to pay, the selling prices in Belgium were lower than those in London. This triumph of management could not have been achieved without effective service, freely given, on both sides of the Atlantic. For instance, two of the largest English firms manage the Commission's fifty or sixty vessels free of all charge—the equivalent of a gift to date of at least £200,000—while in the United States, the Argentine, and Holland, the Commission receive concessions in purchase prices, besides free or reduced railway facilities, harbour dues, wharfage, and agents' services. The £3,000,000 "profits" also represents, to some small extent, the value of the services of those American business men who, here in London, in the United States, and in Belgium, have gladly given practically their whole time to making the work of the Commission efficient. I suppose it is scarcely necessary for me to say that these "profits" are automatically applied to alleviating the distress in Belgium.

To revert to the present needs of the Neutral Commission. If they are to feed the people in Belgium, as the medical authorities say they should be fed in order to enable them to resist disease, an estimated monthly deficit of over £700,000 has to be faced, despite the monthly subsidy of £1,500,000 which is provided in equal parts by the French and British Governments. This deficit must be met by the benevolence of the world, and such profit as can be obtained; but in these days of increase in prices and decrease of the well-to-do in Belgium, profit must obviously be precarious. To help meet this deficit, and especially to relieve the suffering of the children and to check the alarming increase of phthisis among the

adolescents, the National Committee for Relief in Belgium are unceasingly asking for more donations from the British Empire. It is frequently suggested to me that the British Government should lend Belgium, or the Neutral Commission, out of increased taxation the whole amount necessary to keep her people in an adequate state of health. An inquiry of this character came less than a month ago from the Governor-General of Australia, and Mr. Walter Long, the Secretary of State for the Colonies, authorised us to reply as follows:—

"It is impossible to exaggerate the value of the knowledge that a portion of the funds comes from the free subscriptions of people in distant parts of the British Empire. If the money came only from the coffers of the State, there would not be the same sentiment of gratitude and affection which is widely created by the knowledge that citizens of the British Empire in its most distant parts are freely giving for the relief of suffering Belgium to-day."

I can conceive no two sentences that could more effectually answer the inquiry. And it is just as well to bear in mind that, prior to the formation of our own National Committee, the Germans were industriously circulating in Belgium and neutral countries the libel that although Belgium sacrificed herself for us, we were callously allowing her wounds to be bound up by America. The slander was quickly scotched by the magnificent response of the British Empire to our appeal. But if we now expressed our solicitude for Belgium solely in terms of a Government grant, we could hardly expect the public in the United States and other neutral countries to continue those individual donations, each one of which, however small, must bring home to the giver the realisation of the misery brought upon the world by Germany's violation of Belgian neutrality.

This suggests propaganda, and reminds me that I have been asked to say that in the course of its twenty months of existence the National Committee for Relief in Belgium have distributed over twenty-seven million publications, ranging from sixteen-page illustrated pamphlets to one-page leaflets enclosed in a Christmas dinner-table envelope, and including such striking indictments of Germany as Raemaecker's famous poster depicting the Belgian woman with a terror-stricken child at her breast. The important point of this distribution is that, with the exception of a very few hundred thousand, all these millions of copies have been actually *applied for* by branch committees or by individuals, thus assuring a maximum of effect and a minimum of wastage. The figures I have mentioned do not, of course, include countless articles exposing the infamy of Germany, which have been published in thousands of newspapers throughout the world. It may also interest you to know that the expenses, which are *not* deducted from the donations, incurred in raising over £2,150,000, and which include the cost of the propaganda I have just described, do not exceed one per cent.; that the children in our elementary schools, both in the United Kingdom and the Empire Overseas, give, in proportion to their means, far more generously than the adult; that the poorer classes are undoubtedly the best givers, probably because the Belgian cry of hunger and privation comes nearer home; that over £1,450,000 of the £2,150,000 was contributed by Australia and New Zealand; that the War Charities Act was passed as the direct result of repeated representations made by the National Committee for Relief in Belgium, and that we have never spent a penny on an advertisement in a daily newspaper, although we, and Belgium, owe to the press of the British Empire a debt of gratitude that can never be measured in money.

I mention these things because they may be of value to those who are so devotedly co-operating here and throughout the Empire in our work, and because they have relative usefulness to those connected with other war-relief efforts. But they sink into paltry insignificance if one dwells for a moment upon the mental anguish and the physical suffering of the seven and a half million people under German domination in Belgium. For two long years and three months they have awaited deliverance with a fortitude that compels admiration even from the enemy. During all this time most of them have patiently subsisted upon a ration only fit for a beleaguered garrison. Many of the women were widowed in the first atrocious days of invasion, while thousands of others have quite recently lost their husbands and sons—slave-raided into Germany, because they dared and still dare to refuse to work for the conqueror. And, as the months of their third winter of captivity drag on, there is tragic increase in the number of mothers who see their growing boys and girls, for want of proper nourishment, droop and die under the scourge of consumption. It is for these children and their mothers that the National Committee for Relief in Belgium confidently ask the compassion and the loyal aid of the British Empire.

DISCUSSION.

Mr. E. H. Rhodes (Local Government Board), after mentioning that Lord Rhondda would have been present had it been possible, said he would like to deal with the paper from the point of view of the Local Government Board. It was not the province of that Board to have any extensive relations with the National Committee for Relief in Belgium, their work being in connection with the Belgian refugees in this country. The Local Government Board was the Government Department that provided the framework within which the War Refugees Committee had done such excellent work. He had been astonished, as everyone else must have been who had read the early reports of the National Commission, at the number of ships engaged in the work, and at the amount of cargo that was carried into Belgium; and he was still more struck by the loving care in matters of detail which the later reports showed had been displayed, as, for instance, in the care of children and in the providing of special food for them. That loving care in matters of detail was as remarkable as the immense scope of the work that was carried on. Within the last day or two it had occurred to him whether those who were concerned with the Belgians in England could not make more use than they had done of the Spanish-American Commission. There was a large number of Belgian workmen working in this country, many of whom were obliged to leave their wives and families in Holland or Belgium, and the Local Government Board thought it would add greatly to the comfort and contentment of those men if their wives and families could be brought over to join them in this country. That was not a matter of great difficulty with regard to those that were in Holland, but with regard to those in Belgium the efforts of the Local Government Board had resulted in a complete failure. He had got out some statistics a month or two ago, and found that of the 700 people in Belgium to whom letters had been addressed only about fifteen had succeeded in reaching this country, and even in regard to those fifteen he was not quite sure whether their success was not due to some act of dare-devilry or some piece of luck on their own part rather than to the skill of the Local Government Board. He thought in that connection more use might be made of the Spanish-American Commission, for he understood that that Commission was directly in touch with the people; but he supposed an objection to that would be that, as the Commission was a Neutral one, it could not help in a work carried out through a British Government office.

The Right Hon. Sir Joseph Ward, Bt., K.C.M.G., said that, as a representative of New Zealand, he had listened to the paper with great interest, and he thought that the effect of its publication—or the publication of extracts from it—in the press of that country would remove some of the misconceptions that had been circulated with a view to stopping the people there from continuing to assist the Belgians in their dire distress. It was not so very long ago that it had been represented to him, in his official position, that all the contributions the people of New Zealand were giving were really undeserved, and that the refugees in this country were proving themselves to be unacceptable to the British people. But in New Zealand they refused to concern themselves with the attitude of any of the refugees, or with the opinions that were being formed regarding them in any country outside of Belgium. They remembered the fact that at the beginning of the war they, as a section of the British community, had been saved by Belgium from the terrible disaster that might have over taken the British Empire, and, however much information might be viciously circulated with the object of interfering with the charitable disposition of the people of New Zealand, they went back to those first principles which had been their guide in connection with the relief of Belgium. In connection with the author's remarks about the communal system not working satisfactorily, he advised him to go out to New Zealand and live among the Maoris to obtain a contradiction of his opinion. The Maoris lived under a communal system; the majority of them were well-to-do; there was hardly one of them who had been known to go into a household to do menial work for a European; and they had splendid estates and a great deal of money. He had believed all along that a portion of the contributions sent into Belgium was being utilised for the assistance of the enemy; but surely the noble sentiments expressed by the author clearly demonstrated that it was our duty to help in the work of relief, even if we had a barbarous enemy who was prepared to rob the Belgians of their food supplies. The people of New Zealand had already spent some £2,000,000 in providing comforts for their soldiers, besides doing many other things for the support of the men who were fighting for their King and country; in addition to that they had sent £764,000 to this country to help the Belgians and Serbians, and also to help those who had been left by the noble men who fought at the battle of Jutland, and the Government of New Zealand was now giving £10,000 a month to the National Committee in London. They were going to continue that work until the end of the war, and he thought the author's paper would stimulate them in their efforts.

Sir Robert W. Perks, Bt., earnestly hoped that the time would never come when bread tickets and rations would be needed in this country, and, thanks to our Navy and Army, he did not think such things would ever have to be seriously contemplated. One of the most charming features of the flow of benevolence that had gone on in connection with the Belgian and other relief funds was the total

absence of any other consideration in the minds of the donors than the needs of the people. He had received a very considerable amount of money from Canada for distribution amongst the people of this country and our Allies, and, although that money came from people who had rather narrow ways of thinking in some respects, he had been instructed to take into consideration only the need of the people, without regard to their religious opinions or any other matters. He congratulated the author on his paper and also upon the ability which had enabled him to write it. The people of this country were proud that they could always find men to do its work efficiently on land or sea, and he believed that whatever difficulties might confront the country in days to come they would be able to grapple with them as their forefathers had done.

MR. ALDERMAN D. A. GRIFFIN referred to the enormous amount of wealth in jewellery and clothes, etc., contained in this country, and could not imagine how anyone could keep large quantities of such things when there were starving children in Belgium within a few hundred miles of them. In that connection he had made an experiment in Ealing on behalf of the Polish Relief Fund, and appealed in the local press for jewellery and other things of a similar nature. The result was that he got six replies, all being from poor people, which bore out the author's statement that the poor, according to their means, had come forward better than the people who had more of this world's goods.

HIS EXCELLENCY THE BELGIAN MINISTER, speaking in French, expressed the gratitude of his country for the work which had been carried out by the National Committee for Relief in Belgium—a most valuable work of social service and charity. In thanking those who had contributed to the cause, he desired to place on record his appreciation of the part played by New Zealand, to which Sir Joseph Ward had referred. He would like also to thank Mr. Goode for his admirable paper, and for the whole-hearted manner in which he had devoted himself to the task of Belgian Relief.

On the motion of the CHAIRMAN (Mr. A. Shirley Benn, M.P.), a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

OBITUARY.

SIR WILLIAM ERSKINE WARD, K.C.S.I.—The death of Sir William Erskine Ward took place at his residence in Ealing on December 24th. He was born in 1838, the son of the Hon. J. P. Ward, and nephew of the third Viscount Bangor. He was educated at Trinity College, Cambridge, and, after graduating as a Senior Optime, he entered the Bengal Civil Service in 1861. In 1876 he was transferred to Assam, and served as Judge and Commissioner of Assam Valley districts. From 1889 to 1891 he was Judicial Commissioner of Lower Burma, and for the next five years Chief Commissioner of Assam. He retired in 1896, when he was created K.C.S.I. in recognition of his services.

Sir William became a member of the Royal Society of Arts in 1900. He was interested especially in the meetings of the Indian Section, and in 1903 contributed to the *Journal* a long and valuable note in connection with Sir Charles Lyall's paper on "The Province of Assam."

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

JANUARY 31.—MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France." COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

FEBRUARY 7.—ROBERT FORTESCUE FOX, M.D., "The Future of British Spas." SIR THOMAS BARLOW, Bt., K.C.V.O., F.R.C.P., M.D., LL.D., F.R.S., will preside.

FEBRUARY 14.—LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Byways." The RIGHT HON. LORD FARRER will preside.

FEBRUARY 21.—MRS. C. HOSTER, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment."

FEBRUARY 28.—FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

MARCH 7.—JAMES HARRIS VICKERY, LL.B., "German Business Methods."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

FEBRUARY 15.—PROFESSOR H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S., Imperial College of Science and Technology, "The Indian Silk Industry." The RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

MARCH 15.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

APRIL 19.—D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

MAY 17.—SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

January 30.—Octavius C. Beale, Representative and Past President of the Australian Associated Chambers of Manufacture, "Imperial Industries after the War." The Right Hon. Walter H. Long, P.C., LL.D., F.R.S., M.P., Secretary of State for the Colonies, will preside.

February 27. — Alfred Bigland, M.P., "Imperial Assets and how to use them."

March 27.—The Hon. Frederick W. Young, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

May 1.—Philippe Millet, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced :—

Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

Joseph Pennell, "The Artistic Aspects of War Work."

Gabriel Gordon Cleather, "The Drum."

Horace M. Thornton, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

Dr. M. Horn, "The Belgian Colonies."

Dr. J. Augustus Voelcker, "Fertilisers and their Supply in War Time."

Cantor Lectures.

Monday afternoons, at 4.30 p.m. :—

Professor A. Beresford Pite, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

Syllabus.

Lecture I.—January 29.—*The Ancient World.* Civilisation—Method and art in city building—Egypt, Nineveh, Babylon, Athens, and Rome—Greek and Roman colonies.

Lecture II.—February 5.—*Mediæval and Renaissance Periods.* Republics and Duchy towns of Italy—Florence, Venice, Milan, Rome. Free cities of the Empire—Nuremberg, Ghent, Ypres, Bruges, Antwerp, and Brussels. France and Germany. English types.

Lecture III.—February 12.—*The Nineteenth Century.* Paris under the Empire. Vienna—Ringstrasse and buildings. Berlin—Centre and growth. Washington, New York, and Chicago. England—Late Georgian and Victorian progress.

Lecture IV.—February 19.—*The Housing and Town Planning Act*, 1909. Problems for solution. Procedure. Advice to promoters. Preparation of schemes. Architectural considerations. Examples of Garden City movements—Letchworth, Hampstead, etc. The problem of London.

MEETINGS FOR THE ENSUING WEEK.

Monday, January 29...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Professor A. Beresford Pite, "The History and Practice of Town Planning and Civic Architecture." (Lecture I.)

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m. Mr. H. Withers, "Problems of Taxation."

Tuesday, January 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. O. C. Beale, "Imperial Industries after the War."

Asiatic Society, 22, Albemarle-street, W., 4 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Old Brain and the New Brain, and their Meaning." (Lecture III.)

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. G. Avenell, "Richard Jefferies."

Wednesday, January 31...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Miss Ella C. Sykes, "The Work of the Y.M.C.A. in France."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 4.30 p.m. Dr. W. L. Mackenzie, "The Physical Welfare of Children after Infancy from the National, Social, and Public Health Standpoints."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. C. J. Macalister, "The Prevention and Arrest of Venereal Disease in Men."

Thursday, February 1...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. A. F. Joseph and W. N. Rae, "Chromium phosphate." 2. Mr. K. C. Browning, "The detection of traces of mercury salts in toxicological work." 3. Mr. R. V. Wheeler, "'Stepped' Ignition." 4. Mr. H. Rai, "The catalyptic bleaching of oils, fats, and waxes." 5. Mr. P. C. Ray, "Alkaloidal derivatives of mercuric nitrite." 6. Messrs. P. C. Ray and M. L. Dey, "Synthesis of a derivative of the lowermost homologue of thiophene." 7. Mr. S. U. Pickering, "The detergent action of soap." 8. Messrs. E. H. Archibald and H. B. Keegan, "The occlusion of iron by the phospho-molybdate precipitate."

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. G. Donnan, "The Mechanism o Chemical Change." (Lecture I.)

Friday, February 2...Royal Institution, Albemarle-street, W., 5.30 p.m. Dr. C. Carpenter, "The Supply f Gaseous Energy."

University of London, University College, Gower-street, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture III.)

Saturday, February 3...Royal Institution, Albemarle-street, W., 3 p.m. Dr. H. W. Davies, "Line in Plain Chant and Folk Song." (Lecture I.)

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FRIDAY, FEBRUARY 2, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 5th, at 4.30 p.m. (Cantor Lecture.) PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." (Lecture II.)

WEDNESDAY, FEBRUARY 7th, at 4.30 p.m. (Ordinary Meeting.) ROBERT FORTESCUE FOX, M.D., "The Future of British Spas." SIR THOMAS BARLOW, Bt., K.C.V.O., M.D., LL.D., F.R.C.P., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday afternoon, January 29th, PROFESSOR A. BERESFORD PITE, F.R.I.B.A., delivered the first lecture of his course on "Town Planning and Civic Architecture."

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, January 30th; The RIGHT HON. SIR JOSEPH G. WARD, P.C., K.C.M.G., LL.D., in the chair. A paper on "Imperial Industries after the War" was read by Mr. OCTAVIUS C. BEALE, Representative and Past President of the Australian Associated Chambers of Manufacture.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, January 18th, 1917; The RIGHT HON. VISCOUNT BRYCE, O.M., D.C.L., LL.D., F.R.S., in the chair.

The paper read was—

BETWEEN THE TIGRIS AND THE INDUS. THE BEN-I-ISRAEL.

By COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.

On our Indian frontier, some two hundred miles to the west of Peshawur, there is an upland of open rolling plains, intersected and encompassed by rugged mountains, well watered and fertile, enjoying, on the whole, a temperate climate, bright and warm with sunshine in summer and wrapt in the snowy mantle of an Eastern Switzerland in winter. It is, indeed, a Land of Promise. I know nothing more beautiful than the promise of late spring in this land. Then the wide plains are spread with a shimmering sea of upspringing corn, and at the far edges of the plains the lower slopes of the mountains are half-veiled in a light-blue haze which faintly reveals white villages clinging to their craggy spurs. Near by, the running streams of bronze irrigation water, bordered by groves of mulberry and scented willow, are often pink with the scattered petals of peach and almond blossom. It is a land of the vine and the olive and the melon, and of a great wealth of later autumn fruits. In winter it is icebound, with much display of the fantastic beauty of ice shapes in waterfall and river fashioned by the frost grip under the shadow of the snow-capped hills which stand round about its outspread capital; but the winter is the winter of Switzerland. This is the home of the Ben-i-Israel. The capital town, crescent-shaped and hill-protected, is Kabul; and the country about it is the upper Kabul River basin, a part (and perhaps the most important part) of Afghanistan. The name Afghanistan arouses many memories in many of us; one unfailing point of interest in connection with it is its origin. Afghanistan means, of course, no more than the home of the Afghan; but who is the Afghan, and where does he come

from? The name has become crystallised now in Indian history and Indian frontier records for nearly two centuries, but it is apparently only as old as the days of the founder of the Durani dynasty, Ahmad Shah, and it is not a name, so far as I know, acknowledged by any one of the extraordinarily mixed nationalities that occupy Afghanistan. There are Turks and Tajiks, Arabs, Persians and Monguls, with Pathans of mixed origin and all of very ancient lineage, and there are the Ben-i-Israel—but no specific Afghan. I know no one from the mountains of Kafiristan to the deserts of Baluchistan who calls himself Afghan. It is, however, just as well that we should have a recognised British official term for all the peoples governed from the Kabul centre of administration within the boundaries fixed to the Amir's dominions, and the name Afghan is far too useful to quarrel with.

The Ben-i-Israel belong to (if they do not comprise) those Durani clans who established themselves as the dominant power in Afghanistan after the death of the great Persian ruler and robber, Nadir Shah, in the eighteenth century, and, consequently, the Amir of Afghanistan is their ruler and chief. They spread over a great part of the upper basin of the Kabul River, and are to be found on both sides of the Hindu Kush as well as in the basin of the Swat River, where they are known as Yusufzais. In the absence of anything approaching to reliable statistics I will not venture to give an estimate of their numbers, but, at a rough guess, I should put them at about one-fourth or one-fifth of the entire population of all that we call Afghanistan. It is with the Sirdars and the ruling caste of Kabul that I am best acquainted personally—the particular section of Afghan society which insists most strongly on its Israelitish origin. So far as education has prevailed in Afghanistan there are educated classes, but amongst them I have never met a man whose mind could rise above tradition and ritual, or who was capable of discussing an ethnological problem. They possess no history and no written records—the mullahs, or priests, amongst them being the only exponents of their unwritten laws and ritual. They are, of course, all Mohammedans of the Sunni sect, and as such they recognise the validity of the Old Testament; and there are certain curious traces of Levitical ritual in some of their observances—such, for instance, as the sprinkling of blood on the doorposts. But such slight evidence as exists of conformation to Israelitish custom and ritual would be quite worthless as establishing their claim to be true descendants of Jacob did it stand alone; nor do I imagine that their extraordinary capacity for the repetition of a genealogy which invariably ends (or begins) with Kish, the father of Saul, would be much more effective, although I am well aware that genealogies are by no means to be despised as evidence of origin amongst Orientals; because the recitation of a genealogy, passed down from father to son for generation after generation, is the main feature in traditional religious instruction. Apart from these genealogies the Durani can give no account of his origin except that he came from the west. The Turk (*i.e.* the Ghilzai) we know came from the north-east together with the Mongul; the Tajik (modern representative of the ancient Persian Empire) from Persia; but the Ben-i-Israel, differing absolutely in physical characteristic and idiosyncracy from all these, stoutly maintains that he came from the west, and he points to Rum, or Asia Minor, as his starting-point. We must leave it at that, and admit that from such very slight collateral evidence as we can attain he was undoubtedly an immigrant from the west. The absence of any satisfactory historical evidence need not surprise us. The early history of India is but a patchwork derived from the evidence of coins and inscriptions, the result of isolated discoveries. There is, indeed, no recorded history to which we can appeal. But whilst historical evidence is wanting there is another form of evidence altogether which is remarkable for its convincing strength, and that is the evidence of those physical attributes which are derived from heredity. The world is very, very old, and the earliest processes of differentiation in the physical attributes of mankind are lost almost beyond the region of speculation, but where the earliest dawn of tradition commences we find at once that there were widely separated communities—separated geographically, ethnographically, and physically—retaining an original impress acquired in the early days of evolution; and so long as these separate communities have preserved their race continuity unmixed, these hereditary attributes, as betokened by their outward appearance and character, have lasted undestroyed to this day. Indeed, the stamp of heredity appears to be indestructible. The Ethiopian has not changed his skin, nor the Mongul his obliquity; neither have the Semitic peoples of Western Asia lost their physical appearance which the sculptures of Nineveh have recorded.

Amongst the Semitic races the Hebraic cast

of feature and character is perhaps the most familiar and the most unchangeable of all, and no one can deny that the Durani Afghan– the true Ben-i-Israel—possesses it in a very marked degree. I once received a letter from the late Lord Roberts, who had read something that I had written on this subject, in which he said: "I am so glad that you think the Afghans are Jews. I have always been sure of it myself." As a matter of fact, I never thought that they were *Jews*, or said so; but the distinction between the Jew and the Israelite is one that is often missed. The Afghan hates the Yahudi —or Jew—and it is on record that Afghan authorities have even safeguarded Christians against the enmity of Jews in Kabul. Lord Roberts was impressed with the Hebraic personality of the Afghan, just as indeed has been every observer who has come into contact with him. Only a short time ago I was told by a lady who had lived in Jerusalem—whose father indeed is the Bishop of Jerusalem—that it is quite usual for parties of Afghans to visit the shrines of Jerusalem periodically, and that their Hebrew proclivities are at once recognised by other pilgrims. It was an Afghan who, not long ago, shot at some ill-advised tourists who interrupted him in his devotions at Jerusalem.

As a curious coincidence, if nothing more, it is, I think, worth noting that, whilst we may search in vain for an origin of the name Afghan (I have never been able to verify a statement which was made, I think, by the late Dr. Bellew, that it is an Armenian name signifying a mountaineer), there is no difficulty in identifying the name Kabul with that of the well-known place mentioned by many travellers in Palestine, the position of which was determined by the Western Palestine Survey. It was included in the lot of the children of Asher (Joshua xix. 28), and it was one of the cities which Solomon gave to Hiram (1 Kings ix. 13), who was by no means appreciative of the gift. Dr. Robinson, the American traveller, says of it that it formed the military base of the expeditions of Josephus into Galilee. In the fourteenth and fifteenth centuries it was a place of Jewish pilgrimage (note "Later Biblical Researches in Palestine," Boston, U.S.A., 1857). The identity of so peculiar a place-name in localities so widely separated as Syria and Afghanistan is at least curious, if not significant. If we are to concede the claim of the Amir of Afghanistan and of his Sirdars to be Ben-i-Israel (it is a claim that it would be most unwise to dispute in Kabul), it may at least be interesting to discuss the question how their progenitors could have reached the Kabul valley from Armenia, or from any other district "beyond the Euphrates" to which they were originally carried captive. This involves a cursory sketch, both historical and geographical, of the conditions which governed that vast upland territory which reaches from Mesopotamia to the farthest borderland of Afghanistan.

Apart from its academic interest, it is a subject of vital importance to us at the present time to know what lies between the Tigris and the Indian frontier, for events are gradually shaping themselves there which may ultimately affect our own destinies profoundly. We know that for centuries, since the Turk and the Mongul blocked the way to overland commerce between the Far East and the West, commerce has been forced, so to speak, into the sea. There was a time when, across the width of Persia, by at least two world-old high roads, the slow caravans passed and repassed, wearing deep ruts where the camels trod, bringing silks and spices and merchandise from Central Asia and India to Syria and the West. Then came the sweeping hordes of the north-east to interpose a barbaric wedge, which practically shut the main gates of the Eastern trade. European ships then began to find their way to India and China, and one by one, as rival competitors for the seaborne trade sprang into existence, success in securing the greater portion of that trade carried them to the foremost position in wealth and power in the Western world. Finally, England secured it, and has practically held it for two centuries, with what results we know. Let it never be forgotten what England owes to her trade with India. It was the very foundation of her greatness as a sea power.

Now, once again, does there appear to be in a not very remote future the chance of a revival of that old world honoured overland trade which existed before the days of Israel, which brought the treasures of the East to the marts of the West. There is abundant evidence before us that this desire of the nations—the acquisition of the highway to the East—is again a powerful force in international politics. Who can very well doubt that the centre of conflicting interest in the present war is gradually shifting eastwards and trending towards Constantinople (with all it stands for in the Mediterranean, in Egypt, in Asia Minor, Mesopotamia, and ultimately in Persia), as the final issue to be fought to a finish between Germany and Russia? Two notable events have lately been recorded in the

progress of Eastern affairs which bear directly on this important question of overland communications—they are signs of the times and portents of the future. The first railway has been opened in Persia. For the first time has the blue-coated agriculturist of Northern Persia stared open-mouthed at a locomotive bearing a huge national emblem traversing his fields. This is the Russian military line which connects Batum on the Black Sea with Tabriz. The other event is the piercing of the Taurus tunnel by the Germans, which will rapidly bring Constantinople and Bagdad into direct communication by rail, and place a rival enterprise on the Mesopotamian field.

Before discussing the interesting problem of modern railway extension, let us take a brief review of the past conditions of the country which lies between the Tigris and the Euphrates as it was in the days of Israel, when those highways were absolutely open to world traffic, though traversed by slow and leisurely methods.

Samaria was conquered by the Assyrians, and the Israelite tribes were carried into captivity about 721 B.C. This is a fairly well ascertained date. Sargon, the Assyrian conqueror, had not long been king. Five years before, he succeeded the usurper Shalmanesur on the throne. Shalmanesur, again, had succeeded another and greater usurper, Tiglath Pilesur III., who founded the last and greatest Assyrian empire about 744 B.C.

Assyria, in the days of Sargon, was therefore the empire consolidated by Tiglath Pilesur, and it is interesting to note of what that empire consisted in those early days. It was evidently an extension of previous empires which had included Asia Minor, and reached from the Mediterranean to the Caspian and the Persian Gulf, and there seems to be historical evidence that Tiglath Pilesur carried Assyrian commerce, if not Assyrian arms, as far east as Herat, Seistan and Kandahar, and even to the Indian borderland. Whether these remote provinces were ever an integral part of the empire may be doubtful, but it is probable that in the days of the Israelite captivity Assyrians knew their way well enough to Ariana (or Herat), and there is a curious tradition floating in the mists surrounding the early dawn of history that their commercial ventures extended still farther east.

From Herat I once travelled eastward through Afghan Turkestan to the plains south of the Oxus on the borders of Badakshan, in the midst of which plains stands the ancient capital of the Greek province of Baktria, now called Balkh. The modern town is founded on deep buried masses of ancient ruins, about which it is difficult to obtain any authentic information locally.

Ask any educated Afghan of that part of the world to tell you the tale of Balkh, and he will reply that it is the "mother of all cities," older even than the ancient Nineveh, and that its birth story is lost in those traditional mists which ascribe both Balkh and Nineveh to Nimrod as their founder. Why Assyrian rather than Greek tradition should surround Balkh is a mystery to me, unless indeed the very ancient connection between Mesopotamia and the Oxus plains existed even before the days of Tiglath Pilesur, and has impressed itself firmly and permanently on the popular mind. Tiglath Pilesur, as he appears in Assyrian sculpture—curled and anointed and seated on his throne—strikes the imagination as a great personage. He was undoubtedly a great warrior, and it is probable that, in all the width of the vast plateau which stretches from Mesopotamia to the Indian frontier, there was no one of equal strength and ability to dispute his sway—none to prevent the outward sweep of Assyrian conquest over those lands which even centuries before his time may have witnessed the passing to and fro of Assyrian commerce.

As we are now dealing with a region where geographical disposition of mountain and plain has shaped the destinies of nations from the very earliest dawn of history, and as the same geographical factors will yet again shape the course of a history as yet unwritten, it may be interesting to refer briefly to their chief characteristics.

The great plateau of Persia, overlooking Mesopotamia across rugged bands of Kurdish mountains on the west, is shut off from the steppes and highlands of the north by a continuous series of mountain systems, which stretch from Armenia to Afghanistan and beyond through the heart of Asia. But this mountain rim is for a great part of it narrow and easily passable, bordered on the Persian side by a continuous edge of grass land, through which runs the much traversed road connecting Tehran with Mashad and Afghanistan. There are important commercial towns along this route, but the value of it is largely discounted by the fact that the nomads of the steppes north of the mountains still carry their raiding enterprises (alamans) over the hills and into this grass land. South of the strip of cultivable country lie the great central salt deserts separating it

from the next important route traversing Persia from west to east, which starts from Bagdad, follows the old Median Way to Kermanshah, and then passes by Kirman to the Indian frontier. These are the two great important highways between Mesopotamia and India which are bound, both of them, to become something more than mere geographical features in a not very remote future. To the north of that mountain barrier, and extending eastwards and northwards farther than we can tell, in the early dawn of history there dwelt scattered clans of a vast Asiatic horde—Scyths and Sarmatians, of whom we have but a shadowy record. We know, however, that about the period of the Israelite captivity they were crossing the Don, already pushing their way westward towards Europe. I have more to say about them presently.

The geographical position of Nineveh also demands a short examination. South and east of Nineveh, hedging in the plains of Mesopotamia, are bands of wild mountain ranges, rank upon rank, forming a revetment to the Persian plateau, which are extended parallel to and facing the Persian Gulf and Arabian Sea to the Indus basin. They are full of uncouth and unconquered highlanders of many clans and various derivation, some of whom retain the names given them in the records of Herodotus, who wrote five centuries B.C. and about two and a half centuries after the fall of Samaria. Immediately north of Nineveh, where rise the sources of the Tigris and the Euphrates, are the mountains of Armenia reaching to the southern shores of the Black Sea. Through these hills eastward and northward lie those difficult routes, once open to Greece and Assyria, which now, in the process of historical evolution, are again open to military movement. The road from the north, dominated by Bitlis, and the road from the east, dominated by Kermanshah, which have both been in Russian hands, converge on Nineveh—or rather on Mosul, which is the modern representative of that ancient capital, and which is the chief centre of Turkish military activity in Mesopotamia. Thus once again does Nineveh assert the importance of her geographical site as one of the gates to Mesopotamia.

To turn once again to the Ben-i-Israel. The statement that the captive Israelites were transported from Syria to regions beyond the Euphrates is vague. Nineveh itself is beyond the Euphrates; together with all the valleys of the Upper Tigris and Armenia and Lake Van, Erzrum and Bitlis are all beyond the Euphrates so far as Syria is concerned—but Armenia is the country for which there is historical authority for locating them. This, however, is comparatively unimportant if we consider the statement of Josephus that seven centuries and a half later they were still a "great multitude" gathered beyond the Euphrates. So that it is only within the last eighteen centuries that they have become so scattered and absorbed by other tribes and races as to leave no trace of national existence. But doubtless the true Semitic spirit of the nomad possessed them and, like the Jews, they probably spread in small groups right through Asia. There is every reason to suppose that they did so. Unlike the Jews, they sacrificed their national cohesion to the lost faith of their forefathers, which had weakened long before they left Samaria. The rites and ceremonies of Jewish ritual, which are still so powerful a factor in maintaining the national unity of the Jews, had given place to strange forms of worship with a general tendency towards idolatry, nor was that federation of tribes which formed the Kingdom of Israel free from constant internal strife and disturbance. Thus elements of disintegration were deeply rooted amongst them.

There appears to be some confusion of thought as to the identity of the Captive tribes. According to Kitchener (who was a surveyor in Palestine long before he became a War Lord) it is impossible to define the former limits of individual tribes, but there is evidence to show that these limits had disappeared altogether in certain cases before the Captivity. For instance, the tribe of Simeon appears to have retained the nomadic instincts of the race and to have become assimilated with cognate tribes such as the adjacent Edomites and Moabites, only retaining certain holdings within the regions occupied by Judah. Simeon, you will remember, occupied the southern extremity of Palestine, south of Jerusalem, and reached down to Bir-es-Saba (or Beersheba), which is now the base for Turkish military activity in the direction of Egypt. The Captive tribes were, however, described as an "immense multitude" in the first century of our era by Josephus, and they were still "beyond the Euphrates." But as Josephus is the authority for the statement that a million Jews were destroyed with the fall of Jerusalem, and as this is an impossible number, we may perhaps discount the great multitude of the Israelites. There is nothing whatever to show that at this time (about the year A.D. 70, nearly eight hundred years after their captivity)

they were anywhere but in the position assigned to them by the early chronicles—*i.e.* beyond the Euphrates. Still less can we discover evidence that they had migrated in a body to steppe regions beyond the Black Sea and had become incorporated with the Skythic tribes who had then spread into Europe.

A few words about these Skythic nomads may be interesting in view of certain fantastic theories (accepted by thousands in this country) that they absorbed the Israelites, or that, in some inexplicable manner, the Israelites became Skyths. When the Greeks began to colonise on the north coasts of the Black Sea, about the time that Samaria fell, they encountered these steppe nomads as they gradually extended trade eastwards by a route into Central Asia which crossed the steppes from the Don to the Ural (about Orenburg), and thence carried traffic south-westward to regions between the Jaxastes and the Oxus beyond the Aral Sea. From the Don to the Ural the route mainly traversed the country of a kindred people called Sarmatians, but on the Oxus and between the rivers Skyths again prevailed. Thus they were to be found at intervals in regions extending from the Oxus to the Black Sea, and, indeed, it seems probable that they were still further west. They appear to have been first mentioned by Hesiod about 800 B.C., and by the time of the Captivity, 721 B.C., a good deal was known about them, as appears from the writings of Herodotus. They seem to have occupied all Wallachia, and the Dneister was Skythic as far as the Greeks knew it. They were an immense and widespread people, and with them certain European peoples trace an ethnographic connection, based (with some probability) on the similarity of the name Sakai with Saxon, and the known direction and extent of the Skythic irruption into Europe. The Skythic hordes invaded Medea and overran Western Asia about one hundred years after the Captivity, and, after extending their raids into Palestine, they finally destroyed Nineveh. Then, if ever, the Skyths and the Israelites met. But we know that the Skyths retired northward again and that the Israelites were still an immense multitude beyond the Euphrates many centuries after the tragedy of Nineveh's fall. There was no absorption then, and it is inconceivable that it should have occurred after the days of Josephus and the destruction of Jerusalem.

From the earliest days of prehistoric myth and tradition the expansion of the nomads from wide pastoral plains and steppes into the cultivated lands of the mountain valleys periodically changed the destinies of nations and renovated or rearranged humanity; but we never hear much of a reverse process which would spread the cultured people of the valleys away from their fields and their fixed habitations into the open land of the nomad. It is, indeed, almost inconceivable that any considerable tribal emigration left the valleys of plenty and of great natural beauty which lie beyond the Euphrates in the uplands of ancient Medea and Armenia to search for a home in the Southern Russian steppes. The assimilation or absorption of the Israelites by the Skythic tribes may surely be regarded as an ethnographical impossibility. We are confronted with many problems of international assimilation when we deal with national frontiers, but an absorption of one people of strong individuality by another of totally different physical attributes, leaving no trace behind, is practically unknown. I am reminded of the story told about Sydney Smith who, when he was reminded that there will come a time when the lion will lie down with the lamb, replied: "Yes, but with the lamb inside the lion." That, indeed, is descriptive of a process of assimilation which leaves no trace; but no vigorous and virile people have ever been swallowed up in this way. The incomprehensible but immutable laws of heredity prevent it. The impress of physical feature and of character inevitably recurs, sometimes continuously, sometimes after long intervals; but the result is certain, and, indeed, that result is often comparatively independent of numbers and based far more on character. No trace whatever of Semitic (still less of Hebraic) admixture seems to be recognisable amongst the Saxons of Germany, whose claim to Skythic extraction is difficult to overlook. This is what Hippocrates says of the Skyths or Sakai of his time: "They have stout, fleshy, flabby bodies, the joints concealed by fat, their countenances somewhat ruddy. They all looked alike. They lived on boiled flesh, mare's milk and cheese; they never washed, but enjoyed a narcotic intoxication in combination with a vapour bath. . . . The women daub themselves with paste, which they remove every second day." There is a certain irresist ble suggestion of the stout beer-drinking Saxon of modern Germany in this unflattering portrait of a great people, a suggestion which imposes the conviction that Saxon and Skyth are of one original race.

But, having arrived at the conclusion that the legal descendants of the house of Israel are not

to be found in Saxony (and still less amongst the Anglo-Saxons of Britain), and having expressed the view that a strong and virile race of people described as a great multitude in the first century of our era (and still to be found beyond the Euphrates) must have been practically indestructible, and believing, as I do, in the vitality of the Hebraic race of Israel as much as in that of the Jew, where are we to look for these descendants and inheritors of the promises made to Israel? This, indeed, is one of the greatest and most interesting of the ethnological problems of the world. I cannot pretend to offer any opinion of equal value to those of the many Biblical scientists who have investigated it. I can only humbly suggest that we might begin our investigations in those identical regions beyond the Euphrates (a definition which might apply to all the East between the Tigris and the Indus), starting with those districts to which historical evidence points as to their habitat after being carried away captive from Samaria: and the country which suggests itself first is Armenia.

Armenia is to us, quite apart from its ethnographic associations, a deeply interesting country, for we are here face to face with political problems of the future which may greatly affect our position in India. Armenia is not politically to be recognised as a nationality. It is not a kingdom, nor an autonomous state, but simply a wide mountainous region comprising the eastern provinces of Asia Minor to the south and south-east of the Black Sea, which form a western continuation of the great Iranian plateau. On the north it descends abruptly to the Black Sea, on the south it breaks up into rugged terraces which form steps to northern Mesopotamia, whilst it sinks more gently to the west to the lower plateau land of Asia Minor. The general average level of the floor of the Armenian highlands is about 6,000 ft., but the great barren ranges which intersect the country closely from north-east to south-west rise to 12,000 ft. They may be said to culminate in Mount Ararat, which is 17,000 ft. Between the ranges are broad upland valleys with narrow outlets for the rivers where they emerge from the plateau to lower levels south and west. Thus the chief roads through Armenia following the valleys afford that opportunity for military advance which is now being utilised by Russia. Directly northwards from Armenia there is no highway, the Black Sea and the Caucasus shutting off the country from the Russian steppes, so that the flow of human movement in this part of Asia has generally set southward and eastward into Northern Persia, to the south of the Caspian. Until lately Armenia was divided between Persia, Turkey and Russia; but the progress of the war has seen Russia in possession of the greater part of Armenia, and one may venture to prophesy that she will eventually dominate the whole. Such an event in the interests of the Armenians is to be most cordially welcomed, but we must at the same time not lose sight of the remarkable advance towards Russian dominance over the routes that lie between the Tigris and the Indus that is indicated by such an occupation. Clearly the new line from the Black Sea to Tabriz, of which I have already spoken, would be doubly safeguarded by its geographical position with regard to the Caucasian mountains to the north-east and the Russian occupation of Erzrum and Bitlis to the south-west. But this is not all, nor is it nearly all, the strategical advantage which a Russian Armenia suggests. Bitlis and Diarbekr dominate the Tigris, and they are within a measurable striking distance of the upper Euphrates in northern Mesopotamia. Here lies another problem of the future into which I will not enter.

Having thus sketched the position of Armenia, political and geographical, we may turn to the Armenians. The Armenians are a race so ancient that their origin is obscure. The proto-Armenian of the ninth century B.C. appears to have belonged to a tribal family which was widely spread over Western Asia, and which apparently spoke a non-Aryan language. Even in those early centuries there seems to have been a Semitic element amongst them of Assyrian or Hebrew origin. In the seventh century they were conquered by Medes and Persians, who introduced a fresh Aryan type amongst them, whilst it was during the same century that Israelitish captives were transferred from Samaria to "Calachene, Gozanitis and Armenia." There is, therefore, no difficulty in accounting for the strongly-developed Hebrew type which is now to be found amongst them. It must be remembered that only a minority (perhaps one quarter) of the inhabitants of Armenia are Armenian Christians, and the quality of the Christianity they profess depends on the Church to which they belong. There are Protestants and Roman Catholics, Greek Church, Gregorian and Nestorian, and they are as much divided from any ideal of Christian unity as they are divided politically or socially. They may number altogether some three millions, but

it is impossible to make an estimate of their recent losses under Turkish misrule. I trust that the numbers reported as having been destroyed are exaggerated, but they must have been very great. There is a great diversity of type amongst them. The Armenian of the country districts is described as thick-set, coarse-featured, with straight black hair and a long-hooked nose. The Armenian of the towns is more Aryan in appearance and more cultured. They are, however, essentially an Oriental people, the majority preserving the exclusiveness of the Jew and resembling the Jew not only in feature but in their widespread dispersion and tenacity of race. It is the Armenian of the Hebrew type who is scattered in isolated communities all along the northern route to Afghanistan and whom you may find in Herat, although I never met one to my knowledge in Kabul. On the whole, the Armenians are not an attractive people. They may be sober, industrious and intelligent (they are remarkably keen and acute in business matters), but the truth is not in them, and they have no idea of national unity; the men of the plains being usually set against the men of the hills as in the days of primitive humanity. We need look no further for the racial impress and hereditary characteristics of Captive Israel. Most of the Armenians I have met might have come fresh from Samaria, and their conversion to Islam and to Christianity has done little or nothing to modify the ingrained Hebrew type.

There is no difficulty in accounting for their dispersion through Asia. As far back as we can see into the dim past that heralded the dawn of history, we can faintly discern the movements of great multitudes of people over the face of Western Asia, a constant procession of restless humanity struggling and reaching after a better place in the sun than that afforded by ancestral pasture lands; or it may be a vast commingled mass of various nationalities co-ordinated and drilled into army shape by the will of some potentate more mighty even than a German Emperor, moving with the tramp of millions of feet to overwhelm all smaller states in order to amass one huge loosely consolidated and far-spreading Empire. Again, it may be a weary band of captives transferred from a captured town at one end of the empire to develop some great scheme of city building or irrigation at the other. That the Samarian captives should be transferred to lands just beyond the Euphrates was nothing. They might easily have been transferred to lands as far beyond the Euphrates as are the plains of the Oxus about Balkh or even the Indus valley. Thus dimly in the twilight before the dawn we can discern the ebb and flow of a steady commercial tide between Nineveh and Balkh. This may have either preceded or followed the conquest of Persia and of regions contiguous to the Indian frontier by Assyria. Then (or perhaps even before the days of Assyrian conquest) occurred the outward spread of Greek enterprise from the Black Sea colonies to the Hindu Kush, which left Greek settlements amongst the northern foothills of that range and a remarkable colony at Nysa in the wild hills north of Peshawur. This colony, you remember, claimed the primeval leadership of Dionysos and a kinship with Alexander the Great when, centuries later, he invaded the plains of the Punjab. But before the days of Alexander the Persian Empire, under Darius, had claimed all that Tiglath Pilesur had fought for, and it is here and during the period of Alexander's expedition that we touch the first steps of history. We have to thank the father of history, Herodotus, for a very careful geographical compilation which tells us the names of the Far Eastern Satrapies under Persian rule, and refers by name to tribal communities which we can recognise still in their ancient mountain habitat. In those restless days when people were not overburdened with a multitude of goods, when there were no frontier landmarks between the Tigris and the Indus, and all Persia was open to the nomad, it would be most surprising if a restless people like the Israelites did not either, as captives or free agents, spread eastwards in companies in search of a promising field for commerce or employment. There is therefore no inherent improbability in the claim of our Afghan friends to be one such community that has preserved itself comparatively intact through the centuries, like the Jews, or that they should claim a direct descent from Israel.

Thus far our inquiry into the origin of the Durani Afghan has led us to consider, as a subject of more or less academic research, the historical and geographical conditions, human and physical, of that old time-worn and well-trodden region between the Tigris and the Indus which has seen great empires and dynasties rise and fall, and which is now relegated to a position amongst the nations which admits of no pride of race, no military importance—nothing but economic poverty and administrative incapacity. The rights of the highways through Persia, if not Persia herself, have become the desire of

Western nations, and we hear loudly-expressed political aspirations for the open "road to the East." What does the East mean? Does it mean Persia and Central Asia, or does it mean Afghanistan, India, and China—or all of them? I think we may take it that it undoubtedly means India directly and the rest ultimately. I have already drawn your attention to the fact that the iron rails of two great systems emerging from Europe now point eastwards, and that neither of the two belongs to England. One is Russian from the Black Sea, the other is German from Berlin and Constantinople. We, in our small way, never consider any great political or economic proposition except from the standpoint of its immediate effect and its possibilities in the near future under conditions which we gauge by the present. In the matter of a straight overland connection with India we have done nothing, just as in the matter of undersea connection with the Continent we have done nothing. We have waited to see what others might do. We have not completed the easy link with Herat from the Indian frontier, and in the matter of Persia we have been contented with interminable surveys and projects. Paralysed in India for fear of Russia, paralysed (so far as the Channel tunnel is concerned) by fear of France, we have lately been paralysed by fear of Germany and her designs on Bagdad, and we live in hopes, not so much that we shall defeat them, as that our once mistrusted but now well-loved ally, Russia, will do so. Let us hope that the war will shake old England out of her paralysis, and that we shall take our place once more in the world of international enterprise. Anyhow, Asiatic developments will not stand still for us, and I can foresee the time when not one but several open lines of railway will traverse the Persian uplands, and, possibly, the Persian seaboard, too. Then, perhaps, may economic wealth redeem the country which is pre-eminently agricultural, and then will Persia possibly once again rise to importance. But I am not concerned just now with any political problems affecting the Persia of the future. I only wish to indicate what may be done by Russia or Germany, if not by ourselves, in the matter of developing through lines of communication in that country which may ultimately reach our Indian borderland.

Few of us here have any doubt of the value of India to us as an Imperial asset. Probably our methods of administration do not meet with the admiration that they deserve from foreign critics, and we can easily imagine a far more drastic scheme of utilising her resources, both in men and material, than our own were the mastership of India to change hands. Would the Germans, for instance, be content with half-hearted and spasmodic schemes for industrial development? Believing as they do, in a military basis for all schemes of expansion, would they, with a population of 300 millions to deal with, be satisfied with a small army of 150,000? Would they permit a physically weak and unmilitary caste to sow sedition broadcast and to tamper with that army? Would they not, by any means in their power, by education and by propaganda, bind the ignorant masses of India to a blind faith in their Heaven-appointed mission as rulers until German hymns were sung from Cape Comorin to the Himalayas? India, with its traditions, its wealth, its immense possibilities, will always be a potent influence in directing progressive action towards the East, and in such measure as we value India must we watch the trend of railway expansion from the West. It seems probable that either Russia or Germany will dominate Constantinople after the war. We trust and we mean that it shall be Russia. We need not examine closely into the nature of that dominance, but we may regard all the Balkan fighting and all the struggle in Asia Minor as but the preliminary to a decision on the final question of command in Constantinople with all that it stands for in Asia Minor, in the Mediterranean, and in Egypt. There is, however, this difference between them. Russia without Constantinople has still a wide vista of national expansion, if she retains Armenia. Germany, if she loses Constantinople, loses all her hope of Eastern progress.

Let us look at Russia's opportunities first. From Julfa, on the Aras, where the boundary between Russia and Persia is crossed to Tabriz, is only ninety-three miles; Tabriz being, perhaps, the most important commercial centre in Persia, with a great trade in carpets, cotton, dried fruits, etc. Moreover, Tabriz is, or will shortly be, in direct connection with the great agricultural districts round Lake Urumia to the west, and by its connection with Tiflis it becomes an important branch of the whole great Russian railway system. We may be well assured that this important innovation into Persian territory was not undertaken for the sa e of bringing carpets and raisins to the Russian market. We may indicate Tehran as the immediate military objective where railway extension will support the long-considered scheme of Russian domina-

tion throughout Northern Persia. To Tehran there is about 350 miles of somewhat narrow mountain approach under the shadow of the Elburz ranges; but it is a well-known route, carrying a telegraph line, which encounters no greater obstacle than one comparatively low watershed (I do not know the exact height of it) and a bridge over the Sefid Rud, before reaching the important town of Kasbin, about one hundred miles short of Tehran.

From Tehran there opens out at once a magnificent prospect eastward—perhaps the greatest that the Eastern world affords. The military domination of all Northern Persia would be incomplete without the support of a railway skirting on its southern side the great mountain system which reaches from south of the Caspian to the western borders of Afghanistan. We may take it for granted that the necessary line will follow, backed by Russian energy and capital. If it follows the old trade highway to Shahrud, Bujnurd, and Kuchan to Mashad, it will not only tap, and at the same time develop, the resources of a most fruitful district of Persia, but it will set an end to the raiding proclivities of the Turkman horsemen who still, from time to time, harry the open grass lands south of the mountains. From Mashad (about 550 miles from Tehran) will follow an inevitable 100 miles of mountain line to a junction with the trans-Caspian system on the north, and the almost equally certain extension to the extreme Russian frontier post near Kushk, eighty miles north of Herat. Whether it will eventually reach the Oxus plains about Balkh and join up with that further branch of the trans-Caspian system which is expected to link Bokhara with Termez on the Oxus (just north of Balkh) is at present on the knees of the gods, but there is nothing to prevent it except the susceptibilities of Afghanistan, and in the fulness of time it may be looked upon as an almost certain issue. Equally certain in the long future (perhaps not so very long) is the connection with India. The connection *viâ* Herat, easy as it is, has often been discussed and as often dismissed from the category of immediate possibilities on account of the interposition of Afghan territory and the direct opposition of the Amir to railway extensions in his country. It is, however, not necessary that either Russia or we should trouble the Ben-i-Israel in this matter, for there is no insuperable obstacle to a connection *viâ* Birjand and Seistan, to the west of the Helmand River, a connection which would open out local commercial prospects which might eventually go far towards justifying the expense of maintenance. This, however, is not the only nor perhaps the best of the splendid opportunities open to Russia for Persian development and connection with India. So far we have dealt only with what will prove to be an essential condition of Russia's domination of Northern Persia—*i.e.*, the line from Tehran to Mashad. That will inevitably take the precedence of any more purely commercial enterprise as a necessary strategic condition. And here I may perhaps be permitted to record my opinion that Russia's control of Northern Persia will be greatly for the benefit of the country and of the people, who will thus come directly into contact with her methods of civilisation. Russia's goods will flood the markets, and Russian traders will compete with Armenians and Persians in these busy marts; but the great gain to Northern Persia will be security and peace. Nor need we in the least fear the results of this acquisition of a new frontier to Russia, which has long been her natural heritage from its geographical position. Here it is not the Elburz system—which is readily crossed by the raider—but the vast salt midland deserts which form the best natural south-western horizon to Russia's trans-Caucasian provinces. The other obvious opportunity to Russian enterprise is a line from Tehran southwards to Kashan and Isfahan, and thence through the great commercial centres of Yezd and Kirman to Baluchistan and India. Such a line as this would be the making of Persia. Whoever builds this line holds Persia in his hands, and must exercise paramount influence on her destinies. It is Persia herself who should construct such a line as this, and secure for her revenues the enormous advantage of a great through mail service between Europe and the East.

Just what I have so lightly and so inadequately sketched may indicate Russia's position in that contest for the highways to the East which she is undoubtedly waging at present. Germany's position is perhaps not quite so clear. Absolute dominance in the Balkan States and in Turkey is the basis of it all, and the open line to Bagdad is the inevitable sequel which appears at present to be well within her grasp. But what beyond Bagdad? It is, I think, sufficiently clear that she might have visions of a line passing up the old Median Way to Kermanshah, and thence extending itself along that upland road which I have already pointed out as passing by Yezd to Baluchistan. But I very much doubt if any such ambitious programme was ever regarded as

a probable, or even possible, result of a Bagdad occupation. She might, again, look to lower Mesopotamia and an extension to Basra, thus securing for herself not merely the upper half but the whole wealth of the rich Mesopotamian plains when Sir William Willcock's great irrigation scheme ripens into an accomplished fact. That, indeed, would eventually amply repay the outlay on the whole project. It would be a magnificent contribution to the Eastern world's development, and it would bring Germany to a seaport at Basra. That, again, does not seem (so far as any indications as yet presented to the public are trustworthy) to be her present ambition. It brings her into direct conflict with Britain. The line to Bagdad in itself would sufficiently tap the broad wheat and cotton areas, and would go far to drain our Basra trade dry without any excursion southward. Moreover, when Germany makes a bid for Eastern commerce you may take it that her ambitions are wholesale and far-reaching. It is not merely Mesopotamia and Persia, or even India added, that fills her horizon. You must also add China, and remember the millions that she has already sunk in securing a footing in that Celestial republic (if it is a republic). That is perhaps why, in days before the war, it was not Basra that figured in German propositions, but the port of Kawait, south of Basra, commanding the seaway to Basra, and untrammelled by a long shallow-river approach with a bar and bottom of mud. That is perhaps why in these days, when any faint suggestion is made of the peace terms that would suit Germany we always hear that England is to give up control of the sea. What does it mean? The North Sea and the Atlantic have ever been open to German shipping. Many of us have traversed the ocean in Hamburg-Amerika liners and found them comfortable enough. Her ships have been able to come and go as they please. But she has not been able to plant coaling and, incidentally, submarine stations on any coast she pleased, nor has she obtained a port in Eastern waters between Suez and China. Here, I believe, we have the true explanation of German ambitions as regards Eastern trade—ambitions which would involve a direct threat to Indian traffic if not to India herself (for we must remember that India is far more vulnerable by sea than she is by land). This consummation of her hopes is for us to deal with—not for Russia—and the consideration of it brings us back to a fuller appreciation of the meaning of political domination in the Balkans and Constantinople and, finally, of that command of the sea which is our heritage, and which is far more to us than any conquests or expansions by land that we are ever likely to contemplate. We have, however, rather drifted away from the Tigris and the Indus whilst following out this brief consideration of the "road to the East," the command of Eastern trade, which has become the dominant factor in the war.

In conclusion, I would suggest that, apart from these war questions, which are necessarily of vital and immediate interest to us, there is ample and most interesting opportunity for inquiry and research into the academic fields of the history and ethnology in the regions which lie between the Tigris and the Indus. There is, I hope, a prospect that opportunity for such investigation is not far distant. We want to know more than we know at present of the Armenians and their records as well as of the Ben-i-Israel; and we want a closer geographical knowledge of all that lies between Herat and Kabul. Above all do we want a scientific examination of the site of the city of Balkh, which would surely yield results of importance and historical interest such as would rival even those of Nineveh. As for the field which presents such thorny problems to European politicians now, and which will inevitably in the not distant future be subject to the impress of action, political, military and commercial, which will frame new pages of history—the lands which lie between the Tigris and the Indus, and the right of way across them—I have endeavoured to show you that at one end of it lies Armenia and the hills beyond the Euphrates, and at the other the land of a strong and self-contained people who believe themselves to be Ben-i-Israel. In Armenia it seems to me are still to be found the evidences of Hebraic survival which might easily be traced to the lost tribes of 1800 years ago. The Armenians may be but the dregs of a once great people and anything but pure in lineage, but the Hebrew characteristics are still predominant. Over these people is rapidly spreading a new and Christian domination in the shape of Russia, and under Russia we may confidently hope that the hard-tried Armenian will eventually rest "quietly and peaceably governed," and once again lift up his head. Scattered along the highway to Afghanistan are isolated communities of Armenians, holding themselves distinct from their Persian surroundings, engaged in trade, the men with a leaning towards horse-dealing and the women workers of wonderfully fine silk embroidery much

appreciated by the Kabul aristocracy. The Armenian schools are said to be excellent, but I have never visited one of them. At the Afghan end of the highway we find the Ben-i-Israel, strong and amazingly self-confident, calling themselves by the old names Ibrahim, Ishak and Yakub, and holding the gates of their enemies—the passes of the Hindu Kush and of the Indian Frontier—with grim determination; a truly important people—the dominating tribe in a great kingdom. Their King Habibulla is a strong ruler and an astute statesman. His speech to the Mohammedan leaders in India gathered within the walls of the great Mo que at Delhi on the occasion of his visit to India, was, for eloquence, for direct good sense and tactful diplomacy, equal to some of the best efforts of his European contemporaries and far superior to most of them. Habibulla may well be regarded as the warden of our Indian Marches during this great war. It is a sure thing that our turbulent neighbours on the Frontier think much more of the Afghan Amir than they do of any British Commissioner since the days of John Nicholson; and, although we have had our rontier troubles since the war began, there is no suspicion that the Amir has been other than a good and useful ally to us, disdaining the overtures of our enemies, whilst treating them with true Afghan courtesy and hospitality—so long as they were strangers within the gates. As the war winds on, and slowly one by one we gain those points of vantage which will ultimately lead to victory, I think upon the old battle-cry of the Hebrews, which must have often echoed over the hills of Canaan as Joshua led his hosts to victory—"Isra-el, Jehovah fights for us."

DISCUSSION.

The CHAIRMAN (Lord Bryce) said the Society was deeply indebted to Sir Thomas Holdich for a very valuable paper from which they had all learned much. He had given a singularly fresh and vivid account of the physical features of several of the regions he had dealt with, and had also suggested many ethnological questions of great nterest. The most interesting bore upon the possibility that the Ben-i-Israel of Afghanistan might have some basis for representing themselves as the offspring of part of the ten tribes who were carried away, according to the record in the Book of Kings, by Shalmanesur, or by Sargon. The aspect of the few Afghans he had seen round about Peshawur and elsewhere in North-West India led him to agree that certain of the features which were attributed to the Semitic race were also to be seen among the Pathans, but he was not so sure about the alleged resemblance between the Armenians and the Ben-i-Israel. The type of Armenian face seemed to him to differ in its most characteristic features from the Semitic type. It was much more like the Kurdish type, and he thought the most probable view was that both the Kurds and the Armenians belonged to a mixed race, largely Iranian. Both spoke languages of the Iranian group. Having known a very large number of Armenians, he had been greatly struck, not only with their high level of intelligence and industry, but also by their intense patriotism. He did not know of any people who had shown greater constancy, patience, and patriotism under difficulties and sufferings than the Armenians. He personally had always found them perfectly loyal. He had frequently had occasion to give them confidential advice and to trust them with secrets, and never on any occasion had he found that confidence misplaced. Everybody was now agreed that whatever happened at the end of the war, they must be for ever delivered from the oppression they had suffered which had culminated in the recent frightful massacres. As a proof of their loyalty and devotion to their country he might mention that the Armenians living in America had contributed sums enormous in proportion to their number and resources, for they were nearly all persons of small means, for the relief of the refugees who had been driven out by the Turkish massacres. No people during the war had done more in proportion to their capacities than the Armenians had done for the relief of their suffering fellow-countrymen. A large number of them were also fighting as volunteers in the armies of France, where they had displayed the utmost courage and valour in the combats before Verdun. The author had raised a very curious question as to whether the Skyths were connected with the Saxons through the name Sakai. In his own opinion analogies or arguments based upon names were extremely doubtful. For instance, there were three sets of Albanians in different parts of the world—the ancient Albanian people of the Caucasus, the Albanians (who called themselves Skipetar) of the Balkan Peninsula, and, in the third place. Alban was the ancient Celtic name of Scotland. There was no reason to suppose that any one of those three names had anything to do with the others. He desired to join in the tribute of praise accorded by the author to the fine qualities of the Afghans. They were a remarkable people, of great natural gifts in many ways, for whom there ought somehow to be a great future. Probably many of those present knew that their ballads possessed high poetical qualities. An interesting account of these would be found in the book of a distinguished French scholar, James Darmesteter, called "Les Chants populaires des Afghans." Lastly, the author

had dealt with a most important question regarding the great lines of railway which were likely to be constructed and to become of political as well as economic consequence within the next twenty, thirty, or forty years. There could be no doubt that two or three lines would be projected to connect the West with the East, but the author had not mentioned the possibility of a line running along the north coast of the Persian Gulf through Southern Baluchistan to Karachi. He understood there were extreme difficulties to be faced on account of the aridity of the climate, but it must be considered as an alternative or additional line to the two northern ones which had been referred to. The author had indicated his belief that one of the goals of German ambition was the possession of a port on the Persian Gulf. He (Lord Bryce) ventured to express the opinion that when peace came to be made the Allies ought to declare their purpose not to allow Germany to obtain any hold upon Mesopotamia or anywhere in those regions. The projects of Germany which had come to our knowledge showed sufficiently how dangerous it would be to our own interests in India and to the security and well-being of those countries themselves if those designs ever had a chance of being fulfilled. He subscribed heartily to the hope expressed by Sir Thomas Holdich that Germany would on no terms be allowed to acquire Constantinople. Constantinople was of the utmost importance, not only from its control of the Ægean Sea and the ports of the Mediterranean, but also because of the route it opened up from Asia Minor to Mesopotamia. It was in population no more Moslem than it was Greek or Armenian, so there was no infringement of the principle of nationality in extinguishing there the abominable rule of the Turks. He thought it might be taken for granted that one of the points upon which the Allies were most united and would be most firm was the prevention of any hold whatever being established by Germany in the Balkan countries.

[The chair was then vacated by LORD BRYCE and taken for the remainder of the meeting by SIR WILLIAM DUKE, K.C.S.I., K.C.I.E.]

DR. M. GASTER said he belonged to a school of old memories, and the views which he held in regard to the development of the Near Eastern problem might differ from those which some of those present cherished, because he might look upon the developments in a light which did not tally with modern tendencies as the result of the terrible times through which we are passing. The author had shown how uncertain rule had been in certain parts of the world. It might be taken as an axiom that no nation of the West could ever retain permanent domination over the East. The nations of the West might, perhaps, obtain political power and exercise some economic pressure; they might use the East for the purposes of their own enrichment and development; but how much of the East had yet benefited from the influence of the West? Only those could reply to the question who knew the history of Asia Minor or the whole of the East except India, which came under the direct domination of Britain and which was not considered as a place of exploitation, but had benefited by the beneficent rule of an ancient tradition and civilisation. But for the rest of the East there had been nothing but ruin and desolation. A stirring was going on through the nations of the East, and some believed that the result of the war would be a most unexpected one, which would not be realised in a day but possibly in our own generation. A new life was dawning, and the Eastern nations, profiting by the lessons of the West, would probably derive a new impetus and would come back to life in a different manner than some people supposed. The Arabs, the Moslems, and even the Persians were stirring, and he did not know whether any domination from outside would be helpful to their internal emancipation. The Society owed a profound debt of gratitude to the author for the highly instructive part of the paper dealing with the romantic side of ethnology. The Ben-i-Israel of Afghanistan might unquestionably be considered as the last representatives of some of the tribes of Israel that started migrating East even before they were carried away by Shalmanesur or Sargon into captivity. The present was not the place to discuss the mission carried out by the prophets of old, but there was no doubt there had been an intimate connection between all the nations from Palestine, even from Egypt up to the Indus, and perhaps further east as far as China. In his opinion the descendants of a good many of those who were carried into captivity were now living there in modern times as Mohammedans, and the doubt which Lord Bryce had cast upon the admixture of the Hebrew element with the Armenians was, perhaps, unfounded. His own knowledge of the Armenians was not so profound as that of Lord Bryce, but he had come in contact with a great many of them. He could not deny that they had very pronounced Hebrew characteristics and features in their manners, clannishness, charity, and even quarrels. There was some peculiarity about them which, in many ways, reminded one of the Hebrew characteristics, physical as well as mental. It was known, not only from Josephus, that a large number had been living there from the time of Sargon, but that the Seleucid Kings had transferred from time to time large colonies because they used the Jews as soldiers; they did garrison duty all along the frontiers of the Empire. The Jews seemed to be the most trusted soldiers. Papyri which had been discovered in Egypt proved that there was a

Jewish garrison there holding the country in the name of the Persian King. Only the Jews had been able to survive in Asia; no European settler except a small colony had ever been able to prosper; all attempts at colonisation from the West had been fruitless. It had been proved in regard to settlers from the West in Palestine and Syria that within two generations German, French, and English settlers had degenerated. The same was the case in India. The same thing happened with the German colonists in the Holy Land. On the other hand, the Jews who settled in those countries became entirely transformed. The very history of the spread of Christianity could not be understood unless it was assumed that there had been large Jewish colonies throughout the eastern parts of the world. The ancient Apostles never went to the heathen; they went to their brethren in faith, and preached the Gospel to them. It was impossible to understand the story in the Acts of the Apostles and in the Apocryphal Gospels unless it was assumed that in those places to which they went to preach the Gospel they went to their own brethren—to the Jewish population, the Israelites, and the Judaeans; otherwise the whole spread of Christianity would be a greater mystery and a greater miracle than it was at present. That pointed to vast Jewish populations scattered throughout the ancient Babylonian Empire and fully justified the assumption of the author that he saw in the Afghans the last representatives of the ancient Jewish settlers from Samaria and Judaea.

Colonel C. E. Yate, C.S.I., C.M.G., M.P., said he believed most fully that the Ben-i-Israel of Afghanistan were real *bonâ fide* Israelites. He had lived with the Afghans month after month and year after year, and had seen how their souls were possessed with the one great tradition that they were the Ben-i-Israel, and why anyone should try to deny them their heritage he could not understand. The author had brought home to them how the great fight would have to be fought to a finish between Germany and Russia for Constantinople. One or other of those two Powers would have to possess it, and the question of its loss to Turkey was agitating the minds of Indian Mohammedans at the present moment, but he did not think they realised yet what it meant to India. Indian National Congresses and Indian Moslem Leagues had passed resolutions asking for political concessions, in view of the magnificent way in which the Indian soldiers had fought in the present war, but not one of the speakers had taken any actual part in the fighting. It would be much better if those Congresses showed the people of India how the whole of the welfare of the country depended upon who possessed Constantinople in the future, and how necessary it was for them to pledge the whole resources of India in men and money for the successful prosecution of the war. If Germany was the conqueror in the present war and became a world-wide Empire in the future, it meant that India eventually would come under the iron heel of German despotism, and there would then be no place for National Congresses. India had not yet wakened up; it was necessary to explain to the leaders of Indian opinion what the war really meant to India and what might happen to India if Germany came out on top. On the other hand, if Russia obtained Constantinople the great trans-Continental routes across Northern Persia from east to west would be opened up; railways would be made from the Black Sea across to Tabriz, Teheran, and Meshed, and further east towards China. By so doing, Russia would add largely to the security and safety of Persia, the Persians would greatly benefit at the same time, and India would not be touched. The real boundary in future between the spheres of influence of Russia and Great Britian was the great salt desert in Persia. Russia should build all the railways to the north of that salt desert which ran across the centre of Persia, but all to the south should be the British sphere of influence, the present neutral sphere being abolished. If Germany came out victorious it meant, not only that Constantinople would pass to Germany, but that the Baghdad Railway would be completed and the British control of the sea would be destroyed. Germany cried out for the freedom of the seas, but that would eventually mean that Britain, which had policed the Persian Gulf, the Indian Ocean, and the Red Sea for the last hundred years, at great cost, would be wiped out. Germany would have the freedom of those seas, and the ultimate aim of Germany would be the conquest of India. The Amir of Afghanistan, whom he regarded as a most faithful ally, had kept the whole of his country quiet during the war, and if he was well advised he would remain as he was, and not open his country to railway enterprise till all wars and rumours of wars had come to an end.

Mr. Douglas W. Freshfield, in proposing a vote of thanks to Sir Thomas Holdich for his valuable paper, said that one point had not been adverted to in regard to the identity of the Afghans with the Ben-i-Israel — viz. that in no other part of the world were the Jews the dominating ruling and military caste as he understood they were in Afghanistan.

Sir H. Evan M. James, K.C.I.E., C.S.I., in seconding the motion, regretted that the author had not taken the Ben-i-Israel far enough east to a very curious old habitation of undoubted Israelites and Hebrews to be found to this day in the centre of China, showing how the ancient Hebrews wandered about the world.

The resolution was carried unanimously.

SIR THOMAS HOLDICH, in reply, said that no one knew better than he did the fallacy of drawing the analogy between names, to which Lord Bryce had referred. It did not follow that because the ancient Skyths were called Sakai and the modern Germans were called Saxon that they were connected. There were other reasons which he was afraid he had not made sufficiently clear in his paper. History was quite clear that the Skyths were, at the time that he had been dealing with, making their way towards Central Europe; and it was also tolerably clear, from what Hippocrates said, that the ancient Skyth was exceedingly like the modern German in physical constitution. It was not merely the analogy between the names that he trusted to.

THE RT. HON. SIR HENRY MORTIMER DURAND, G.C.M.G., K.C.S.I., K.C.I.E., writes:—The derivation of the word "Afghan," as explained to me when I was in Kabul in 1879, is from Picah, a leader of the Ben-i-Israel, who led an Israelite swarm to Herat. His people were called Picahani, whence, by corruption, Apicahani, and so Afghan. But Oriental derivations are bold.

EIGHTH ORDINARY MEETING.

WEDNESDAY, JANUARY 31st, 1917; COLONEL SIR THOMAS HUNGERFORD HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Chellew, George, 99, Chevening-road, Willesden N.W.

Davis, William Alfred, Pusa, Bihar, India.

Robb, Captain William James Paulo, A.O.D., c/o Sir Charles R. McGrigor and Co., 39, Panton-street, Haymarket, S.W.

Stone, Judge Kimbrough, Kansas City, Mo., U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Boag, George L., Aguilas, Murcia, Spain.

Lovejoy, Frank W., 1433, Main-street, Racine, Wisconsin, U.S.A.

The paper read was—

WITH THE Y.M.C.A. IN FRANCE.

By ELLA C. SYKES.

Everyone knows that there are many temptations lying in wait for our splendid soldiers both abroad and at home, and the Y.M.C.A. has done and is doing a splendid work in coping with them.

The Red Triangle symbolises a helping hand stretched out to every soldier irrespective of his creed, and in the Y.M.C.A. Hut religious and social differences are laid aside. The Church of England Padre and the Jewish Rabbi, the Roman Catholic Priest and the Nonconformist Minister, are made equally welcome when they wish to hold their services, for the main object of the Hut is to be a counter-attraction to drink and dissipation, and if anyone in my audience is in doubt as to its usefulness I will merely remark that in one place in France the Town Major affirmed that the advent of the Y.M.C.A. had meant a reduction in crime of 80 per cent.

During my stay across the Channel there were no fewer than 171 Y.M.C.A. centres in France and Flanders, some being within a mile of the German trenches. One hut had been destroyed by shell fire, and in another a dug-out had been provided for the workers as their hut had already been "wounded" no less than fifty times. I was told of one worker who had had a narrow escape. He was talking with three soldiers outside when his companions were killed instantaneously by a bursting shell. He himself, though hurled across the road by the concussion, escaped without a scratch, but naturally suffered from shell-shock.

The huts are all portable and built in sections, in order that they may follow the army as it advances, but here and there other buildings have been taken for the work, such as an old church, a convent, a mayor's parlour, a cinema hall, and so on.

Princess Victoria of Schleswig-Holstein had started a scheme by which women could do canteen work in these huts in France, and I was fortunate enough to be able to do such work for three months.

I had a certain amount of adverse criticism from my friends, who considered that I might be more usefully employed, and I confess I had a few doubts myself. However, the first soldier who told me that the presence of women workers made the Hut "a bit of home" exorcised them for good. The scene of my labours consisted of two huts, one reserved for services and entertainments and the other having a long counter at one end with lockers underneath containing the different articles, numbering about a hundred, that were sold by the Y.M.C.A. to the soldiers. Two officials managed the place, did the accounts and so on, but we women were allowed a free hand at the counter, and the first duty of a newcomer was to learn the price of everything and be able to lay her hand on it automatically.

Halfway down the hall was the cash desk, where penny tickets were issued, and across the room the tobacco counter made its appearance later on, proving a boon, as it diverted much pressure from the end counter.

We worked between seven and eight hours daily in the Hut, motoring to and from our temporary home, a quaint little villa on the sea-front, where I shared expenses with three other women workers.

A short time after my arrival we had the proud distinction of beating the record of any other hut in France, 2,800 francs, or 28,000 penny tickets, being taken in one day. This was a strenuous time for the workers, as the calls upon us were unceasing, the Hut being thronged with a tightly-wedged mass of men from almost every British regiment, who struggled with one another and fought good-humouredly in their efforts to reach the counter. The crush got greater as the afternoon wore on, and often between two or three hundred of the long French loaves would be consumed in the form of bread and butter.

The huge supply of sandwiches that we had made during the comparative lull of the morning, the numberless hard-boiled eggs, and the many dozens of cakes from the pastry-cook were soon devoured, and we would take turns to cut up scores of the currant cakes imported from England, each block having to be divided into forty-eight slices, and we would empty the cases full of "dollies," "jollies," and "gingers," piling them on to large dishes, or fill baskets with penny or twopenny packets of biscuits.

In one of the cases the workers found a letter from a girl packer offering herself in marriage in the most bold-faced way to any soldier who might come across her missive. We have often been told that the postscript is the most important part of a lady's letter, and this one was no exception to the rule. In it the girl mentioned that if the warrior happened to be married she hoped that he would be a "dead sport" and hand on her offer to any bachelor friend!

The question of supplies was often a difficult one, as the main bulk came from England, but our Hut was seldom short of food or tobacco; and I was not surprised to hear that it was no uncommon thing for the Y.M.C.A. Commissariat in France to handle two thousand cases of provisions in a day.

Our customers had usually a deep-rooted objection to giving the whole of an order at once, and the worker had in consequence to race up and down the counter perpetually to supply their needs.

For example, a little "Bantam" from Glasgow would demand a "brad" with a frown as he held up a ticket, and when this was procured he would curtly remark "anither," and the worker would have to run back again to the huge basket full of buttered slices. A finger would then be pointed imperatively at a custard tartlet ("dead hands" the men called them among themselves), or a vanilla sandwich (dubbed a *religieuse*, or nun, by the pastry-cook) would be required. Probably such articles as bootlaces, an indelible pencil, fags, "bachelors' buttons," or toffee would be demanded one at a time and paid for separately, the customer having a peculiarly brusque manner and ignoring such social amenities as "please" or "thank you." I found "broad Scots" somewhat trying now and then, until I grasped that by "cannel" a candle was meant, though it was very easy to confound this with "caumel," signifying a packet of caramels. I earned the contempt of one customer when I handed him a tin of boot polish in response to the word "nugget." He scornfully rejected it, and, instead of explaining what he wanted in other words, he asked in louder and louder tones for "nugget," until a Southerner came to my aid and explained that "nougat" was desired. Perhaps my most crushing experience was on one occasion when I was helpless at the request for a "bawbeen" (by this a reel of cotton was meant). My Jock remarked in scathing tones, "And I spak' to ye in plain English"!

One snowy April day the heroes of Gallipoli who hailed from the Antipodes invaded our Hut and made themselves at home in it at once. Taking them all round, the Anzacs were the finest-looking men I had ever seen, tall and sinewy, with clear-cut features, frank eyes, beautiful teeth and a proud gait. They were particularly easy to get on with, and extremely polite, addressing us always as "Madame" or "Lady," and invariably saluting us if we did them any little extra service. "Are you English? I've never met an English lady before, and I'd like to have a yarn with you, whenever you aren't busy," was said to all of us over and over again, or it would be: "You ladies keep us from the drink," or "I don't think I could stick this camp if it weren't for the Hut—I'd desert, as I'm not accustomed to all this discipline."

Our sympathies went out to the newcomers, partly because they were so homesick. Many

had had no letters for six or even eight months, and more than one told me that the longing for home became worse when he got news. Others complained that they found great difficulty in writing to the dear ones twelve or fourteen thousand miles away, though some appeared to cover many sheets, and used to pick a flower or a leaf from the bouquets we kept on the counter in order to enclose them. By the way, I heard that the cost of the paper and envelopes provided free by the Y.M.C.A. comes to £1,000 a week. Cards with the flags of the Allies or floral devices worked in coloured silks were bought by the hundred to send home, the men being particularly fond of those with sentimental inscriptions—"Let's have something a bit sloppy," as they expressed it.

All of us were confided in to a flattering extent. One man appealed to me to keep his money; another, alas, killed on the Somme, gave me a parcel to send to his wife; but I plumed myself most on being able to supply the address in London of the long-lost uncle of one of my new acquaintances. This was accomplished owing to the energy of a friend of mine, and I was thankful that my Anzac had not found me a broken reed.

We shopped for any soldier who needed our services, as the men were not allowed to go freely into the town. They entrusted their watches to us to be mended in an embarrassing profusion; identification discs were lost and must be replaced; members of the Public School Corps required French books and various manuals to fit themselves for their coming commissions, and a Scotch sergeant requested me to arrange French lessons for him. He fancied that he would soon grasp the language because he had discovered that "assiette" was "ashet" in Scotch, and "gigot" had the same meaning in both languages. We supplied brown paper, string, labels, needles, cottons, and so on gratis, and every now and again a man would enlist our admiration for some rather fearsome *objet d'art* that he was anxious to send to his "best girl" at the Antipodes, confidently relying on our good offices to provide a box, sealing-wax, and string.

We kept bandages and iodine at hand, and I fancy that by this simple precaution we saved many a careless man from the septic poisoning so common in the camp.

Any fatigue or discomfort that we might experience was promptly forgotten when we grasped how greatly our services were appreciated. "If you ladies knew what the whole camp thinks of you it would hurt you," was said to me on one occasion, and to all of us the remark was made, "You always serve us as if you liked doing it."

We were urged again and again not to overtire ourselves, although on Mondays there was usually disappointment expressed that we had absented ourselves on Sunday afternoons (our time off each week). I must own that I was secretly flattered when an orderly remarked to me, "On Sunday afternoons we always get such a rough lot of fellows; we have to be pretty sharp with them I can tell you." Our own experience was totally different, as throughout my stay none of us ever had a rude word or look, nor did a single soldier, be he Britisher or Anzac, ever swear in our hearing.

Every now and again, when the officials were short-handed, I was asked to take a turn at the cash-desk, and enjoyed the change of work, especially on pay-days, when the crowd seemed unending. The men stood in a long queue, never jostling one another, and amused to see me measuring off the strings of ten centime tickets with the help of notches cut in the desk. When five or seven francs' worth of tickets were demanded, it was like reeling off ribbon at a counter. The highly-paid Anzacs usually preferred twenty-franc notes, and always asked for their tickets in multiples of ten; but the British soldier never seemed to grasp the decimal coinage, and would demand twelve or six tickets out of his five-franc note. New arrivals offered English coins, and were interested to find that a shilling was worth 1 fr. 45 c.; half-a-crown, 3 fr. 55 c.; 28 fr. 55 c. being the equivalent of a pound note, though an English sovereign only realised 27 fr.

The men were fond of saying, "A meal for me and my mate," to this I would reel off ten tickets; but when it came to, "Some tobacco and matches, three fags, a cup of tea and a 'brad,'" a little mental arithmetic would be needed.

Many of the Scotch were very taciturn, and frequently pointed to the articles they wanted to buy without vouchsafing a word. I always humoured them, and business was transacted in complete silence on either side. However, once at the tobacco stall I forced a dour-looking sergeant to speak. At the time matches were extremely scarce, and in order to enable them go round we were only allowed to sell one box to each man. "Jock" pushed two tickets towards me and pointed at the matches. I gave him one box and returned

the second ticket, which he thrust vehemently at me again, and again I returned it in silence. This was too much for him, and he broke into speech, "Twa matches." "Oh, you aren't dumb after all," was my remark, and his stern face broke into a broad grin while I explained why his demand could not be granted.

At intervals the hut was visited by the concert parties organised by Miss Lena Ashwell, the talented artistes being received with such storms of enthusiasm that they said it would be hard to perform to any ordinary audience after the soldiers. The men also had their own sing-songs, the Australians producing a mesmeriser who sent us all into fits of uncontrollable laughter by the comic situations into which he put the men whom he had hypnotised.

The library was a great resource, but though the Anzacs carefully recorded their names and the titles of the books they took out, they were, alas! not nearly so punctilious in the matter of returning the volumes. Certainly some grateful spirits not only brought back missing books—in too many cases found on rubbish heaps—but presented the library with others; yet, on the whole, the arrivals from the Antipodes swept the shelves clear as if they had been visited by a swarm of locusts. Most of the men liked novels, but some were keen on serious reading, and one youth remarked, as he showed me a book of poems, "I read one of these in the morning and it hangs about me all day."

Two or three weeks after the slouch hat and the broad-brimmed round felt had invaded our hut, an epidemic of mumps and measles broke out among the Anzacs, and accordingly we were out-of-bounds to all the British troops. Until this order was repealed we had about half our usual customers, and in consequence were able to individualise the men from the Southern Cross, and make friends in a way that was impossible when business was in full swing.

Those who were ill were supposed to be confined in an isolation camp; but one day as I entered the library an Australian remarked to me cheerfully, "This place *is* a boon. I really don't know how we could get on in the isolation camp without these books!"

As I talked with man after man I began to realise that, consciously or unconsciously, they felt that the cause that had drawn them from the ends of the earth to offer their lives in its service was a holy one. Many had come with a splendid disregard of material interests. "It must have been a great wrench for you to have left your wife and children," I said to one man, and he replied, "Yes, it was; but I should never have been satisfied all the rest of my life if I hadn't come."

That seemed to be the spirit animating one and all, and my heart went out in particular to the gallant boys, several of whom had enlisted pretending that they were full-grown. One well-built youth, gently bred, had joined from school at the age of sixteen. "I used to be frightened at first when the fellows got drunk and fought in our tent," he said, "but now I only laugh," and I thought of his mother far away in New Zealand.

Another boy, like a prize-fighter in appearance and always full of mischief, returned to the hut after a spell at the Front. At my greeting his face puckered up like that of a child about to cry, and he exclaimed, "I don't want to go back to make the daisies burst up; I want to go home," and the words came from his very heart. "Of course you do, but you must see this through first!" seemed to cheer him up, and he muttered, "That's so," nodded his head approvingly, and swaggered off quite in his old style. There was a great anxiety in the eyes of another poor lad who murmured to me, "I have only just come from New Zealand and am going up the line to-morrow; I don't know how I shall behave," and I grasped that he was haunted by the fear that he might not play the man, and trust that my words were a help to him. It was hard to say good-bye when our friends left us for the Front. The Hut would be quieter on those days, so many men writing what would be their last letters, and one hated to feel that numbers would never return and that more would be maimed and broken for the rest of their lives. As an Australian remarked to me, "None of us understood what war meant until the first shipload of our wounded arrived. It was when our people saw the blinded men that they began to realise things a bit."

We had several victims of shell-shock in the hut, some mere boys with a haunted, scared look in their eyes. A splendidly-built Australian told me that he could not understand how, after nineteen months of warfare without a scratch, all his nerves should give way because some earth from a bursting shell had struck his face. But the Medical Board had declared him unfit for further service and he came to bid me good-bye. "I haven't a single bad mark against my name," he said. "Before I left home I promised my sister that I'd behave, and I've kept my word, though it's been hard not to drink sometimes when I've been with the boys." I

trust that the sea voyage and his temperate habits have restored him to health, for I always regretted that the splendid men who had come across the world viewed drunkenness with too lenient an eye. As one of them remarked to me, "We don't look upon it in the way you do; it isn't anything to keep a man awake at night about."

Another thing that struck me was the longing that one and all had to see the Mother Country. "I hope I'll get wounded badly enough to be sent to Blighty," was a wish I heard more than once. One man told me that it was necessary for a man to have friends in England, his ticket being made out to their address. This regulation, he explained, was no bar to the Anzacs, who evaded it by means of faked addresses.

"What did you think of England?" I asked an Australian who had just returned to camp after a fortnight in the Old Country. His face lit up as he answered: "It was all that I thought and a great deal more!"

The huts are only part of the work done by the Y.M.C.A. in France. We were living in a district of hospitals, and the Society looked after the relatives of wounded officers and privates, housing them and driving them to see their sick. The relatives of privates were lodged free of charge in a comfortable hostel, and those of officers could stay in a charming villa, where I never shall forget two mothers, the lives of whose sons hung in the balance from day to day, nor the stricken couple who arrived too late to say farewell to their loved one. There was tragedy round us. If we sat in the beautiful garden where cuckoos called all day and nightingales sang after dusk in the spring, our thoughts would be turned from the loveliness round us by the menacing boom of the guns at the Front some forty miles away.

The Y.M.C.A. also brought much comfort to the relatives of the dead by means of photography. One of their helpers made it his special task to photograph the graves of fallen soldiers. I visited one cemetery among the sand-dunes and the pines, the French having given half the ground to our heroic dead, reserving the rest for their own men.

Our soldiers lie in long rows, each mound marked by a simple wooden cross, on which hangs a moss wreath set with flowers, and one felt that this God's Acre was a specially sacred spot. The gallant company who lay there, cut off in their prime, had offered themselves willingly for a great cause, and had, indeed, been "faithful unto death."

"Snapshots from Home" was another scheme by which the men at the Front, whether from Great Britain or the Dominions, could be cheered by the arrival of portraits of their families taken by willing helpers. An Australian who heard of this told me that he had just received the joyful news that he was a father, and he hastened to fill in the form that would procure him a picture of his baby-boy.

The Y.M.C.A. also undertook the task of meeting night and early morning trains full of tired men bound "up the line," who were thankful for a hot drink and a smoke.

Three of us took part in this work on one occasion in order to have the experience. We had to be at the Y.M.C.A. headquarters by 3 a.m., where we found a big car loaded up with urns of tea and cocoa and a case of biscuits, and we followed in its wake to the railway siding. Here a train full of reinforcements pulled up, and we did a brisk trade with exhausted Tommies who had been travelling all night. chattering with them in the intervals of filling their billies and mugs. The men rushed up for tea until the last moment, making us fear that they might be left behind, and as the train started we distributed chocolate and cigarettes, bidding our brave defenders good luck as they went off to their unknown fate.

Three happy months slipped by all too fast, and I left the Hut with deep regret. I often wonder how my friends have fared. In my mind's eye I can see one, a born soldier, who had served under the banner of Italy during the Tripoli campaign, and who knew Constantinople well. We always exchanged greetings in Italian when we met at the counter, and he told me many interesting things.

Then there was the white-haired man, erect and sinewy, who had been one of the earliest leaders in the campaign that ended in the complete triumph of the Labour Party in Australia. He had known Hughes when the eloquent Prime Minister was poor and obscure, and he took much trouble in explaining to me the state of politics under the Southern Cross.

I must not forget John and Alf, our cheery and willing boy orderlies from Birmingham, who had enlisted at the tender age of sixteen. "We couldn't stand the posters, and as lots of grown-up men wouldn't do their 'bit' we just had to enlist." Thus John explained to me one day, and added that when his widowed mother, whose only child he was, heard the news, she took to her bed for a fortnight! Another of our orderlies, a Britisher, had had a chequered

career. He had worked as a cowboy in the States, and had got a lucrative post in Mexico when he was captured by Villa's forces and cast into prison. "They only gave me food when they felt like it," was his comment on his imprisonment, and finally he was brought down to the coast in chains. On the outbreak of war he took ship to Tasmania and enlisted under the Australian flag, going through the Gallipoli campaign without a scratch.

These are but a few glimpses of a great and splendid company—men who at the call of duty went to meet death with "proud, unreluctant feet"—one and all offering up their lives without compulsion in the sacred cause of Justice and Freedom. Over and over again I felt what a privilege was mine to be able to serve in ever so small a degree the very flower of the race to which I have always been so proud to belong, and I realised more keenly than before how immense was our debt to the manhood of the Empire and how impossible of repayment.

DISCUSSION.

THE CHAIRMAN (Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.), in opening the discussion, said it was a peculiar pleasure to hear at first hand such an interesting and amusing account of the actual working of the Y.M.C.A. huts in France, and the social conditions under which the workers laboured. Some people might ask what the Y.M.C.A. huts had to do with the Royal Society of Arts, whose interests were avowedly in the direction of Arts, Manufactures, and Commerce. Independent of the fact that at present everything which concerned the welfare of our soldiers at the Front ought to concern the Society, there was another side to the question. The Society prided itself on being by no means a negligible factor in the educational schemes of the country; and the work of the Y.M.C.A. had its educational side. Judging from what Miss Sykes had said, there were two principal things which the soldiers learned in the huts, the first being Christianity and the second good manners. He did not suggest for an instant that as a rule our soldiers went out to the Front without at any rate the rudiments of knowledge of how they should behave socially. As Miss Sykes had stated, there must be very many gentlemen among them, and there were some points on which British soldiers could give a lesson to those of other countries. A story appeared in one of the newspapers a short time ago of a German soldier who was dragged out of his trench covered with mud, cold, wet, shivering and hungry, and who was brought to one of the huts. What he expected to get when he fell into the hands of the English he (the Chairman) did not know, but what he did get when he reached the hut was a cup of hot coffee, and he then said with a smile, and in perfectly good English, "This is the spirit of the English." He could not vouch for the truth of the story, but all present could vouch for the sentiment which the German prisoner expressed. The sentiment of chivalry towards a beaten foe had existed amongst British soldiers through all the centuries. It had come down as a hereditary asset to them from the days when Edward the Black Prince entertained King John of France, on the field of battle, after having well beaten him at Poitiers, and probably it extended even farther back than that. But a man learned more than that when he joined the Army. As a general rule, men after being put through a certain period of training were enormously improved physically, and in every way they were much more of men than they were before. They also acquired a certain mental equipment; their outlook on things in general was broadened, and they had altogether a better appreciation of the social conditions of the world than they had before. Ian Hay narrated a story of one of his smartest sergeants who, when he joined, was a Socialist, and whose first idea was to organise so far as he could a small trades union in his own company—not for the purpose of raising a strike against military orders, but for securing a fund which would go towards paying the fines of himself and his comrades for disregarding any duty imposed upon them. He found that it did not altogether answer, and when he further discovered that the money that was deducted from his pay on account of his own faults did not go into the pockets of the officers of the company but really went to the King, his view of the whole situation entirely changed. The Army was perhaps the greatest democratic institution in the country; in it men of all sorts met and rubbed shoulders together and learned things from each other, and by degrees they acquired, at any rate to a certain extent on all things that really mattered, something of the same opinion. He could not help thinking that, with the assistance of the huts, which brought all the men together, and promoted social communion between them, there was a very powerful educational factor at work in France, and it would be a thousand pities if the great work which was now being carried on there was to fail hereafter—if some of that educational process did not "stick." When the men came home and were distributed by hundreds of thousands over the country it would be a very great surprise to him if they did not leaven the whole lump in England, and produce something like a social revolution which had nothing to do with the Socialists. But it was clear that if hopes in that direction were to be fulfilled the work of the Y.M.C.A. in France should continue steadily at home in this country when the war was over, and that, he understood, was exactly what the Y.M.C.A. desired to bring about. They had

already taken the matter in hand, and had erected huts in different places all over the country, including twenty-five in London. He had heard it said that the Y.M.C.A. hut system would find itself up against the publicans and the public-houses. Personally, he did not think that would prove to be so. He had a strong conviction that publicans were as good and as sound a body in the British Constitution as any other community; they did not want men to misuse or abuse their hospitality, but they naturally wanted to make the best of their trade, and in order to do so they did all they could to make it attractive. The Y.M.C.A. must do the same, and to that end they must not drop the system which they had adopted in France. It was to be hoped that, when the work of the Y.M.C.A. was in full swing in this country to an extent which had hitherto not been the case, the ladies of the country who could bring such an influence to bear on the manners of men would not hold back because the war was over, but would still take the same interest in the work of the huts—not at all in the position of barmaids, but by using their influence to make the huts a home for the men. If the ladies who were kind enough to undertake the work were gifted with the graces of sympathy and of wisdom possessed by Miss Sykes he had the greatest hopes for the future.

The Secretary read the following letter from Dr. J. Holland Rose, University Reader in Modern History at Cambridge :—I wish to emphasise the need which already exists for more workers, always provided that they are capable, tactful, and in other respects suitable. I believe that even now it is not fully realised how great is the need for additional workers. My experience at the large base-camps, and my talks with those who recently came from them, confirm my impression as to the growing strain on the helpers out there. The new military regulations, imposing the term of four months' service, and compelling the wearing of uniform both by women and men, will probably hinder a certain number from going out. And if many intending workers are thus hindered there may be a serious crisis, which will render it difficult to carry on the work efficiently at the ever-increasing number of huts. For myself, I believe that this crisis will soon be upon us; and it is well that that prospect should be faced in time by those on whom lies the responsibility for keeping up an adequate supply of workers in France.

Mr. E. T. Scammell said the suggestions made by the Chairman in regard to the work of the Y.M.C.A. at home in the future were very wise and opportune. Last Christmas an effort was made by the Y.M.C.A. to obtain hospitality in the homes of the people of the country for any soldiers on leave from the Front. Hundreds of invitations were received from people in London anxious to entertain men during Christmas time, but the effort was not a complete success owing to a much smaller number of men receiving leave than had been anticipated. A fresh effort was now being made with the object of providing hospitality in the homes of the people for convalescents from the hospitals, and the Y.M.C.A. required ladies of organising ability and sufficient leisure to organise a movement of the kind.

On the motion of the Chairman a hearty vote of thanks was accorded to Miss Sykes for her very interesting paper, and the meeting terminated.

PHEASANT FARMS IN SOUTH CHINA.

In a recent report the United States Consul-General at Hong-Kong states that the raising of domesticated pheasants is upon a very large scale, particularly in certain districts near Yunnanfu, Yunnan Province. Direct shipments to the United States are on the increase, and inquiries indicate that the trade with America will increase even more rapidly.

At present the pheasant feathers and skins reaching Hong-Kong come almost entirely from the farms near Yunnanfu. There are twelve of these farms of some importance, one of them raising well toward 200,000 birds a year, while the total output is estimated to be in excess of 300,000, and may be much larger. The farming includes both the golden and the silver pheasants. The golden are the more common birds, but there is comparatively little difference in the demand for the two varieties.

The birds are raised much as are ordinary fowls, the eggs being hatched in Chinese incubators and the chicks handled in native-made brooders on the larger farms, though the rule on the smaller farms seems to be to rely upon the hens for hatching. The birds are usually worth at Yunnanfu from $1 to $1.20 silver currency (from $0.40 to $0.50 gold) each. Of this value about half represents the value of the skins and feathers for export, and the rest the value of the meat of the birds. Most of the birds are killed about the Chinese New Year, and are used for food during the festival season, though there is a good demand for them at all times.

There is practically no distinction made in the price of the male and female birds as a rule. Before the war the business of shipping the feathers of these birds out of Yunnan to Hong-Kong and thence to Europe was largely in the control of German firms. Since the war the business has been taken up mostly by French and Danish firms. The immensely larger portion of the output of the farms goes to Europe, Marseilles still being the chief centre of the trade in Europe, the understanding being that many of the birds are there prepared for re-export to the United States, and particularly South America. The skins and feathers are seldom used locally by the Chinese, though a few are employed now and then in Chinese theatrical costumes.

The skins are cured simply by immersing in a solution of carbolic acid for disinfection, by treatment with an alum preparation, and steaming and then drying. They come to Hong-Kong usually in small bales protected by matting, but the more valuable feathers and skins are separately wrapped in paper and packed in cases. They are usually exported from Hong-Kong in cases.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Cotton Substitutes.—It can be foreseen that the general public will soon be wearing and using more cotton goods. The severer restrictions upon the disposal of wool and flax ensure that cotton will have to be taken instead, and the compulsion will not be universally welcome. In the eyes of a good many householders cotton is admirable in its own allotted sphere, but outside of a definite range of purposes is looked on as a trespasser. The prejudice is intelligible, for, great and powerful as cotton has become, it is still somewhat of an upstart in the Western world. Its position has been gained by elbowing others aside by dint of superior cheapness. Silk, linen or wool goods may be cheaper for containing cotton, but they are not inevitably better, and cotton has incurred some of the odium in which substitutes and adulterants are commonly held. Hence, no doubt, some of the disposition to avoid calling cotton goods by the plain name "cotton," and to give them names which more or less shroud their identity. It is not to be doubted that "velveteen" is a better trade name than cotton velvet, although at some date it must have been exposed to the same objection as "flannelette." No objection can be made to fancy names which raise no suggestion of false composition, and these should increase in view of the growing disposition of manufacturers to identify themselves with their product.

Merits and Demerits.—Cottons are open to some rational as well as unreasoning objections, for no one textile embodies all the virtues. Cotton is a better heat conductor than wool, although that disadvantage is remediable in part by raising a fine fur of fibre upon the surface to check conduction and retain a layer of dry air. It is less strong than flax, and no means of making short-fibred cotton as strong as long-fibred linen are likely to be found. It is more inflammable than the animal fibres, and although means of fireproofing cotton are not unknown, the expense of treatment is material and its effects are not final. Cotton absorbs moisture freely and when wet is cold to the touch; but it can be converted at need into respectably efficient macintoshes and raincoats. Cottons can be made as lustrous as need be for those who want sheen, and no fibre is capable of so many mutations. In wear it soils more quickly than wool or silk and in general its colours are not so permanent, although this rule is not absolute. In their degree all these characteristics influence the sale and popularity of cotton goods in substitution for other articles; but perhaps the most effective commercial improvement which could be introduced would be one to prevent cotton cloths from creasing. A fabric that could regain its straightness after folding in the same way as silks and wool goods do would make fortunes for its producers. Under ordinary conditions, cottons are shut out from an immense additional consumption for no more substantial reason than that they look tumbled too soon in wear.

Consumption of Cotton.—It cannot be affirmed of a certainty that an increased substitution of cotton for linen and wool will increase the world's consumption of raw cotton within a given year. The flax and wool crops are small things beside the 12,000,000,000 lb. or so of raw cotton now annually produced, and cotton is consumed preponderantly by races which barely know an alternative material. Every new employment helps to dispose of more cotton; but a consumption which grows at the average rate of 500,000,000 lb. a year is capable of accommodating many fluctuations of demand. Highly important British manufacturers have well before their eyes the desirability of cultivating a winter trade in relatively heavy and warm cotton cloths, and their efforts should have a chance of fruition this year. The progress already made in adapting cotton to new uses does but make it more certain that there remain possibilities still unexplored, and these may form the subject of unlimited research work.

Neglected Business.—The Continentals in the past have done much more weaving upon single worsted warps than have British manufacturers, whose warps are usually of two-fold thread. The single warp makes a more lissome cloth, draping rather more elegantly, but somewhat more difficult to weave. The single yarn calls for more preparation than two-fold to enable it to withstand the chafing of the loom, and with fair unanimity British manufacturers have fought shy of the business. In a discussion of the technical aspects of the problem before the Bradford Textile Society a spinner remarked that no sooner did he begin to think of making single-warp yarn for weaving than he was confronted with the superior attractions of orders from the hosiery trade. To both spinners of yarn and weavers of cloth the trade has appeared as second-best business. The comparison is conditioned, of course, by the price obtainable in competition with the Continentals, and more

speakers than one agreed that this particular class of trade could be captured. One line proposed was the evolution of single-warp cloths showing some distinct difference from the Continental type—a development which cannot be dismissed as impossible. It has, however, to be borne in mind that Labour asserts a voice in all such matters, and that it is not precisely as easy to get weavers for work on sized and relatively frail warps as for the stouter two-folds. Thus wages, which are already higher than the Continental scale, would presumably have to be increased.

Trade Restrictions.—The suggestions offered by the National Service Department to retailers as to their trading relations with the public have not been too favourably received in drapery circles. They may be taken, no doubt, to reflect the official desire to curtail non-essential expenditure, and conceivably they will have some such effect. The pious warnings against extravagance in dress issued a year ago produced a temporary check perceptible at the drapery counters, but the caution has long vanished into limbo. Manufacturers have shown no reluctance to reduce the credits granted by them, and an important curtailment of the credit given to wholesalers for tailoring cloths has been effected by English, Scottish and Irish woollen and worsted manufacturers. In the promiscuous rush for goods producers have been able to evade those who have asked for long credit, and to tighten trading terms all round. The natural inclination to reduce risks has been hastened by a cost of materials which has doubled or trebled the amount required to carry normal stocks. Retailers cannot be quite insensitive to the same influences, and it may be believed that the paternal official suggestions will not prove the greatest obstacle to their further trading. Absence of goods to sell will be a more radical deterrent than absence of window-show or credit payments, and drapers can by no means count on obtaining the same kinds and quantities as hitherto. Wool and flax materials, at any rate, will not be released with the accustomed freedom for the purposes of home trade, and engagement on Government contracts or export orders is becoming indispensable to existence as a manufacturer.

Sumptuary Laws.—The principle in modern sumptuary regulation is that of striking at the source of import or of manufacture, and it was presumably not in order to facilitate administration that our forefathers laid restriction upon the individual wearer. Possession of £100 a year formed a franchise under the Act of 1337 forbidding the wear of anything but English cloth. Under the Scottish statute of 1471 "the gret pow'te of the Realme" was cited as the reason for forbidding "silks in gown doublate or cloks except knychts mestrallis and herralds," and to those who "may spend a hwndretht punds wortht of lands rent." Velvet hats and caps were forbidden in 1566 to any man "under the Degree of a Knight or of a Lordes soone." It is not clear that the motive of these ordinances was invariably national economy, and they need not be pursued beyond the Scots law of 1621 preventing servants from wearing clothes other than cloths, fustians, canvas or stuffs of the national manufacture. At a time when furriers are currently supposed to have done better than ever, a petition of the Mystery of Skinners of London to Elizabeth may be noticed. The handicraftsmen maintained that the usual wearing of furs in 1590 was "utterly neglected and eaten out by the too ordinary, lavish and unnecessary use of velvets and silks," which rival articles were said to be "drinking up the wealth of the realm."

Japanese Silks.—Customers for Japanese silks have had to bear with so much irregularity in the quality of supplies that the news of the opening of a new Conditioning House in Yokohama should be welcome. Warehouses and a finishing works for imparting a standard finish to the cloths are being built. It is well understood that irregularities of quality are to be expected in goods made and finished by a multitude of small producers, and it is acknowledged that foreign buyers have tempted the small man to adopt deceitful courses. Something may be hoped from measures which give the trade an approach to the uniformity that is more readily secured under large-scale factory conditions. Inspection has not shown itself a sovereign cure in the past, and it will be interesting to see whether the new standards are proof against deterioration. The plain uncoloured silks of Japan stand in extraordinarily little danger from direct competition, and better prices could be realised by saving the buyer any doubts of the quality to be received.

OBITUARY.

The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.—Lord Cromer died at his residence in Wimpole Street on January 29th. The son of Mr. Henry Baring, M.P., he was born at Cromer Hall, Norfolk, in 1841. At the age of fourteen he entered the Royal Military Academy at Woolwich. As he himself stated at a meeting of the Royal Society of Arts, he was at first rejected for short sight, but pressure was brought to bear on the authorities and "the matter was reconsidered." In 1858 he entered the Royal Artillery. Three years later he went to the Ionian Islands as A.D.C. to Sir Henry Storks, and in 1865 he acted as Secretary to the Commission sent to Jamaica

to inquire into the outbreak of the coloured population and the repressive measures adopted by Governor Eyre. In 1872 he went to India as private secretary to the Viceroy, Lord Northbrook, where he had ample opportunities, during the terrible famine of 1874, of studying some of the economic problems of the great Dependency.

In 1877 Major Baring was sent to Cairo as Commissioner of the Egyptian Public Debt, and in 1879 he was appointed Controller-General in Egypt. The following year he returned to India as Financial Member of the Council of the Governor-General. In 1883 he was recalled to Egypt as H.M. Agent and Consul-General, a post which he held for twenty-four years.

Lord Cromer's work in Egypt, which won for him the reputation of one of the greatest Empire builders in British history, is too well known to call for more than a mere summary here. Under the malign misgovernment of Ismail, this naturally rich and fertile country had sunk to "the *nadir* of financial chaos and popular misery." In the course of his rule Lord Cromer reduced the public debt (which had sprung from seven to a hundred millions sterling in a dozen years), practically abolished forced labour, eased the land-tax by one-third, cleansed the Courts, and established institutions capable of supplying competent men for the judiciary and the Government service.

Lord Cromer was elected a member of the Royal Society of Arts in 1903. In 1908 he received the Society's Albert Medal "in recognition of his pre-eminent public services in Egypt, where he has imparted security to the relations of this country with the East, has established justice, restored order and prosperity, and by the initiation of great works has opened up new fields for enterprise." In the same year he took the chair at the meeting when Sir Hanbury Brown, K.C.M.G., read a paper on "Irrigation in Egypt under British Direction," and in 1911 he again presided when Mr. P. J. Hartog read a paper on "Examinations in their bearing on National Efficiency." He served on the Council as Vice-President from 1908 to 1912.

GENERAL NOTES.

BANK MEETINGS.—Sir Edward Holden, Chairman of the London City and Midland Bank, Limited, in the course of his address to the shareholders on January 26th, described the constitution of the Reichsbank, the institution in which the whole German financial system is centralised and which acts as the Central Bank for most of the great Joint Stock Banks of Germany. The direction of the bank was actually under the control of the Kaiser through his Minister Herr von Bethmann-Hollweg. In addition to its function as the Bank of Issue for the Government, the Reichsbank carried on an ordinary banking business. In times of peace its notes were secured according to law by gold bullion or coin, Imperial Treasury notes, and current German money to the extent of one-third of the notes in circulation, but since the war, by the law of August 4th, 1914, they had added another form of cover, viz., the notes of the Darlohnskassen, *i.e.* of the small loan banks which had been established in different parts of the Empire, and at which advances on all kinds of securities might be obtained. The custom of the Reichsbank, however, had always been to maintain a minimum of 33⅓ per cent. in gold only against its notes in circulation. When the war began in July, 1914, the amount of such notes in circulation was about 94 millions sterling, and by the end of December, 1916, they had reached a total of 403 millions. The gold held by the Reichsbank on July 23rd, 1914, was 68 millions, being a percentage of 71·7 of the notes in circulation, and by the end of December, 1916, the gold amounted to 126 millions and the percentage had fallen to 31·3. During the progress of the war the Reichsbank authorities had foreseen that there would be a tremendous increase in their note circulation, and that it would be absolutely necessary for them to put forth extraordinary efforts gradually to increase their gold as the note issue increased. Travellers had been stopped at the frontiers and their gold taken from them in exchange for notes. The clergy had preached from the pulpits urging the people to give up their gold and take notes. Gold ornaments had been melted down and the metal sent into the Reichsbank in exchange for notes. The soldiers had been given certain privileges in exchange for any gold which they could collect. More recently the holders of hoarded coins were threatened that the gold in the possession of the bank would be recoined and the design changed, and that their hoarded pieces would no longer be regarded as currency.—Mr. Walter Leaf, presiding at the annual general meeting of the London County and Westminster Bank, Limited, dealt, among other subjects, with the schemes for mobilising of securities. The two conspicuous and highly successful operations of the past year had been the mobilisation of securities by way of sale or loan to the Government, and the system of continuous day to day loans by means of short-term borrowing on Treasury Bills. The former operation was designed to deal with the foreign exchanges, and more particularly American. The New York rate had been a subject of much anxiety to all, and particularly to the small committee of experts who had had the great responsibility of dealing with it. The second outstanding feature in our national finance at the end of the year was the enormous amount of indebtedness at short date—over £1,100,000,000 in Treasury Bills with not more than twelve months to run. In addition to this there were many hundreds of millions in Exchequer Bonds, in War Certificates, in loans to the United States, and in Currency Notes. It was clear to all that the time had come

when we should undertake a great operation both for the funding of our short-term indebtedness and at the same time make a fresh loan on the largest possible scale. The system of day to day borrowing had proved marvellously successful in providing the necessary money, but it had now reached a point at which a halt must be called, the position strengthened, and a strong call made to the nation for a great loan.

Royal National Life-boat Institution.—The number of lives saved by the life-boats in 1916 was 1,185. This constitutes a record for the whole period of ninety-three years since the Institution was established, and there has seldom, if ever, been concentrated within three days of life-boat work a more splendid series of achievements than those of the Deal, Kingsdown, Ramsgate, Tynemouth, and Holy Island life-boats, which resulted in the rescue of 230 lives between November 19th and 21st. The life-boats have also rescued over 750 sailors, soldiers, doctors, nurses, and others from H.M. ships and other vessels which have been mined, torpedoed, or otherwise in jeopardy from causes arising directly out of the war. Unfortunately twenty-one life-boatmen have perished since the outbreak of war, and three splendid life-boats and several others have been severely damaged since August, 1914. At the same time the income of the Institution was £21,000 less in 1916 than in the previous year. The Institution is urgently in need of funds to enable it to carry on its work which has been the means of saving no fewer than 54,600 lives.

American Gift for Belgian Relief.—Fellows of the Society who read Mr. W. A. M. Goode's paper on "Relief Work in Belgium," published in the last number of the *Journal*, will be interested in a message from the Exchange Telegraph Company, published in the *Times* of January 31st. From this it appears that in response to an appeal by Mr. Herbert C. Hoover, Chairman of the American Commission for Relief in Belgium, 500 members of the Rocky Mountain Club, of New York, composed of the principal mining men of the Far West, have decided to forego the building of a club house, and hand over £200,000 —the estimated cost of the building—to Mr. Hoover for the purposes of Belgian relief.

Wine for French Soldiers.—According to the official returns, in 1915 the French Government requisitioned and purchased 4,685,000 hectolitres, or more than six hundred and eighteen million large bottles of claret or red wine, for the use of its armies. Each officer and man daily receives half a litre of wine, and the actual number of bottles requisitioned in the year mentioned was 927,630,000 half litres. During the following twelve months of 1916, when the forces engaged in the different theatres of operation had been largely increased, the total quantity of wine requisitioned by the Government of the Republic is estimated at 6,000,000 hectolitres, representing one thousand one hundred and eighty-eight million half litres (792,000,000 large bottles).

MEETINGS OF THE SOCIETY

(Up to Easter).

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

February 7.—Robert Fortescue Fox, M.D., "The Future of British Spas." Sir Thomas Barlow, Bt., K.C.V.O., M.D., LL.D., F.R.C.P., F.R.S., will preside.

February 14.—Lawrence Chubb, Secretary to the Commons and Footpaths Preservation Society, "Highways and Byways." The Right Hon. Lord Farrer will preside.

February 21.—Mrs. C. Hoster, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment." Lady Emmott will preside.

February 28.—Francis A. Hocking, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs."

March 7.—James Harris Vickery, LL.B., "German Business Methods."

March 14.—Dr. J. Augustus Voelcker, "Fertilisers and their Supply in War Time."

March 21.—G. W. Jones, "Colour Printing and some Recent Developments." Carmichael Thomas, Chairman of the *Graphic* and *Daily Graphic*, will preside.

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

February 15. — Professor H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial College of Science and Technology, "The Indian Silk Industry." The Right Hon. Lord Islington, P.C., G.C.M G., D.S.O., Under-Secretary of State for India, will preside.

March 15.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

February 27. — Alfred Bigland, M.P., "Imperial Assets and how to use them."

March 27.—The Hon. Frederick W. Young, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m. :—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

Syllabus.

LECTURE II.—FEBRUARY 5.—*Mediæval and Renaissance Periods.* Republics and Duchy towns of Italy—Florence, Venice, Milan, Rome. Free cities of the Empire—Nuremberg, Ghent, Ypres, Bruges, Antwerp, and Brussels. France and Germany. English types.

LECTURE III.—FEBRUARY 12.—*The Nineteenth Century.* Paris under the Empire. Vienna—Ringstrasse and buildings. Berlin—Centre and growth. Washington, New York, and Chicago. England—Late Georgian and Victorian progress.

LECTURE IV.—FEBRUARY 19.—*The Housing and Town Planning Act*, 1909. Problems for solution. Procedure. Advice to promoters. Preparation of schemes. Architectural considerations. Examples of Garden City movements—Letchworth, Hampstead, etc. The problem of London.

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m. :—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 5, 12, 19.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 5 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Professor A. Beresford Pite, "The History and Practice of Town Planning and Civic Architecture." (Lecture II.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. S. M. Zwemer, "Islam and Animism."

Royal Institution, Albemarle-street, W., 5 p.m General Monthly Meeting.

Geographical Society. Burlington-gardens, W., 5.30 p.m. Dr. J. Scott Keltie, "Thirty Years' Work of the Royal Geographical Society."

Electrical Engineers, Institution of (Western Local Section), Merchant Venturers' Technical College, Bristol, 5 p.m. Mr. J. S. Peek, "The Parallel Operation of Electrical Power Stations."

TUESDAY, FEBRUARY 6 ... Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Dr. G. de Swietochowski, "The Future of Poland."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "The Old Brain and the New Brain, and their Meaning." (Lecture IV.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. G. W. Humphreys, "The Main Drainage System of London."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. S. Gardner, "English Gothic Foliage Sculpture."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. L. A. Borradaile, "On the Structure and Functions of the Mouth-parts of the Palæmonid Prawns." 2. Dr. F. E. Beddard, "On the Scolex in the Cestode Genus *Duthiersia*, and on the Species of that Genus." 3. Professor H. G. Plimmer, "Report on the Deaths which occurred in the Zoological Gardens during 1916."

Röentgen Society, at the Institution of Electrical Engineers, Victoria-embankment, W.C., 8.15 p.m. Dr. E. E. Fournier D'Albe, "Some Properties and Applications of Selenium."

WEDNESDAY, FEBRUARY 7...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Dr. R. Fortescue Fox, "The Future of British Spas."

Aëronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Lady Barrett, M.D., "The Rôle of the Midwife and the Protection of Motherhood."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Annual Meeting. 2. Messrs. J. E. Marsh and C. G. Lye, "The Quantitative Estimation of Mercury in Organic Compounds." 3. Mr. G. D. Elsdon, "The Shrewsbury and Knapp Process for the Detection of Coconut Oil." 4. Mr. W. Partridge, "The Detection of Rose Petals in Blue Pill."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Dr. G. B. Grundy, "The Evidence of the Anglo-Saxon Charters on the Road System of England."

School of Oriental Studies, London Institution, Finsbury-circus, E.C., 5 p.m. Mr. C. O. Blagden, "Malay."

THURSDAY, FEBRUARY 8...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. G. Donnan, "The Mechanism of Chemical Change." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. A. L. Coburn, "Vortography and its relations to Modern Art."

Optical Society, at the Chemical Society, Burlington House, W., 7.30 p.m. 1. Annual Meeting. 2. Mr. J. W. French, "More Notes on Glass Grinding and Polishing."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. R. Townend, "Frequency Changers."

FRIDAY, FEBRUARY 9...National Land and Home League, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 10.30 a.m. Conference.

Economics and Political Science, London School of, Clare Market, W.C., 5 p.m Mr. O. C. Beale, "Metals as the Base of Imperial Strength."

Royal Institution, Albemarle-street, W., 9 p.m. Mr. D. Jones, "Experimental Phonetics and its Utility to the Linguist."

Malacological Society, Burlington House, W., 7 p.m. Annual Meeting. Presidential Address: "Systematic List of the *Marginellidæ*."

University of London, University College, Gower-street, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture IV.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. Annual General Meeting.

SATURDAY, FEBRUARY 10...National Land and Home League, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 10.30 a.m. Conference continued.

Royal Institution, Albemarle-street, W., 3 p.m. Dr. H. W. Davies, "Colour from Diaphony to Debussy." (Lecture II.)

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Dr. LIABILITIES AND ASSETS, 31st December, 1916. Cr.

Dr.	£	s.	d.
To Capital Paid up, viz.: £2 10s. od. per Share on 1,912,317 Shares of £12 each	4,780,792	10	0
„ Reserve Fund	4,000,000	0	0
„ Dividend payable on 1st February, 1917	322,703	9	11
„ Balance of Profit and Loss Account, as below	243,538	5	10
	9,347,034	5	9
„ Current, Deposit and other Accounts	174,620,724	17	9
„ Acceptances on account of Customers	7,220,780	12	2
	£191,188,539	15	8

Cr.	£	s.	d.
By Cash in hand (including Gold Coin £7,000,000) and Cash at Bank of England	47,973,686	4	4
„ Money at Call and at Short Notice and Stock Exchange Loans	8,844,377	19	10
„ Investments:			
War Loans, at cost (of which £1,490,000 is lodged for Public and other Accounts), and other British Government Securities	33,399,534	13	6
Stocks Guaranteed by the British Government, India Stocks, Indian Railway Guaranteed Stocks and Debentures	326,406	10	0
British Railway Debenture and Preference Stocks, British Corporation Stocks	1,924,813	0	4
Colonial and Foreign Government Stocks and Bonds ...	751,520	12	11
Sundry Investments	788,021	0	10
„ Bills of Exchange	23,336,817	0	9
	117,345,177	2	6
„ Advances on Current Accounts, Loans on Security and other Accounts	63,868,856	17	4
„ Liabilities of Customers for Acceptances as per contra ...	7,220,780	12	2
„ Bank Premises, at Head Office and Branches	2,753,725	3	8
	£191,188,539	15	8

Dr. PROFIT AND LOSS ACCOUNT for the year ending 31st December, 1916. Cr.

Dr.	£	s.	d.
To Interim Dividend at the rate of 18 per cent. per annum for the half-year ending 30th June, 1916, less Income Tax	344,217	1	3
„ Dividend payable on 1st February, 1917, at the rate of 18 per cent. per annum, less Income Tax ...	322,703	9	11
„ Investment Account	632,501	0	6
„ Payment of Salaries to Members of the Staff serving with H M. Forces and Bonus to others ...	207,606	13	2
„ Balance carried forward to next Account	243,538	5	10
	£1,750,566	10	8

Cr.	£	s.	d.
By Balance from last Account	113,597	15	2
„ Net profits for the year ending 31st December, 1916, after providing for all Bad and Doubtful Debts	1,636,968	15	6
	£1,750,566	10	8

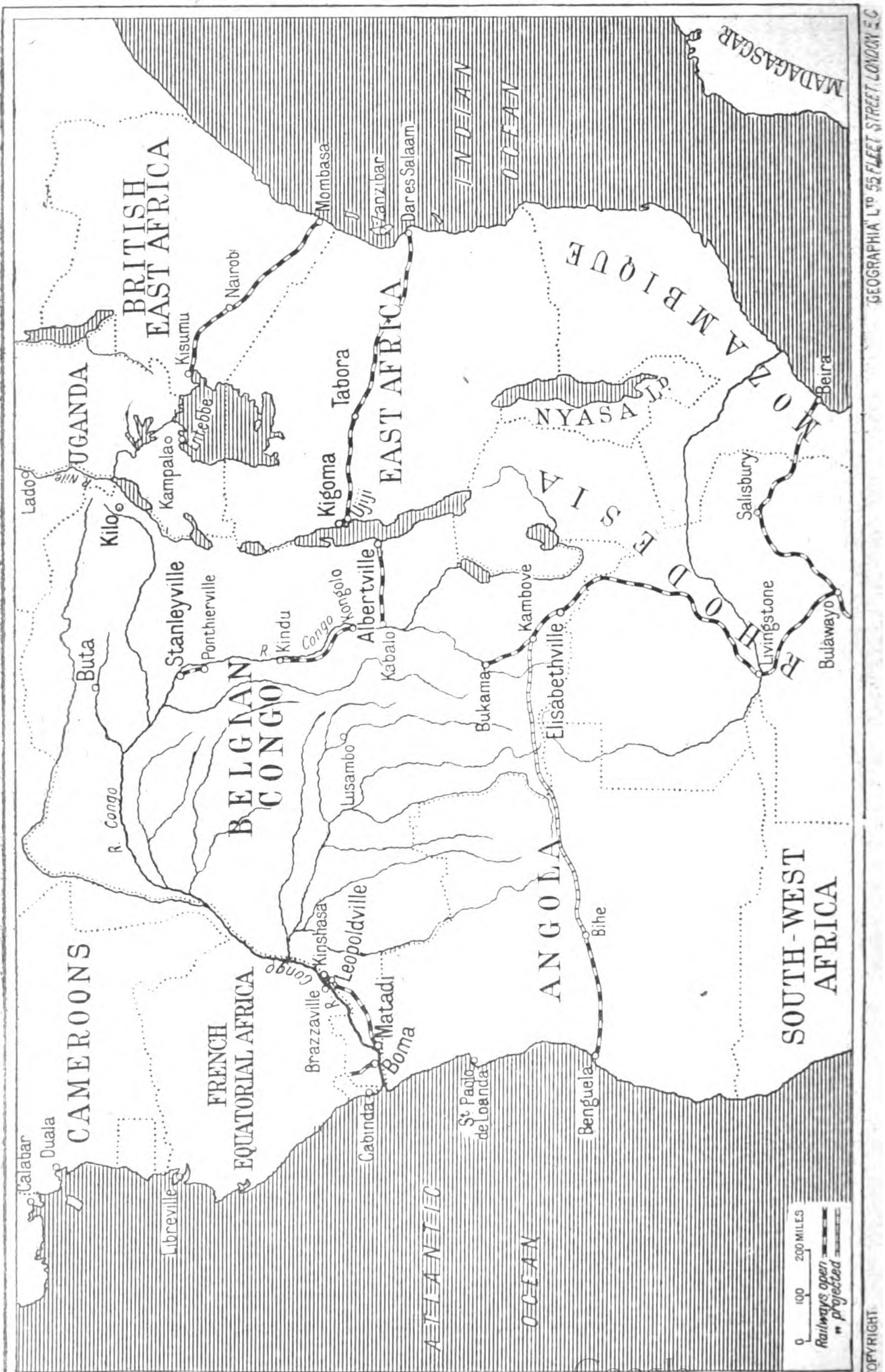
EDWIN H. HOLDEN, *Chairman and Managing Director.*
W. G. BRADSHAW, *Deputy-Chairman.*
H. SIMPSON GEE, } *Directors.*
PERCY E. BATES, }

Report of the Auditors to the Shareholders of the London City & Midland Bank, Limited.

In accordance with the provisions of Sub-section 2 of Section 113 of the Companies (Consolidation) Act, 1908, we report as follows:—

We have examined the above Balance Sheet in detail with the Books at Head Office and with the certified Returns from the Branches. We have satisfied ourselves as to the correctness of the Cash Balances and the Bills of Exchange and have verified the correctness of the Money at Call and Short Notice. We have also verified the Securities representing the Investments of the Bank, and having obtained all the information and explanations we have required, we are of opinion that such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us and as shown by the books of the Company.

London, *11th January*, 1917. WHINNEY, SMITH & WHINNEY, Chartered Accountants, *Auditors.*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INDIAN OCEAN
MADAGASCAR
MOZAMBIQUE
NYASA L.
RHODESIA
BELGIAN CONGO
CAMEROONS
FRENCH EQUATORIAL AFRICA
ANGOLA
SOUTH-WEST AFRICA
ATLANTIC OCEAN
Mombasa
Zanzibar
Dar es Salaam
Nairobi
Kisumu
Entebbe
Kampala
Tabora
Kigoma
Ujiji
Lado
R. Nile
Kilo
Stanleyville
Ponthierville
Kindu
R. Congo
Kongolo
Albertville
Kabalo
Buta
R. Congo
Kambove
Bukama
Elisabethville
Lusambo
Salisbury
Beira
Livingstone
Bulawayo
Kinshasa
Leopoldville
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Journal of the Royal Society of Arts.

No. 3,351. VOL. LXV.

FRIDAY, FEBRUARY 9, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 12th, at 4.30 p.m. (Cantor Lecture.) PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." (Lecture III.)

WEDNESDAY, FEBRUARY 14th, at 4.30 p.m. (Ordinary Meeting.) LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Byways." The RIGHT HON. LORD FARRER will preside.

THURSDAY, FEBRUARY 15th, at 4.30 p.m. (Indian Section.) PROFESSOR H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S., Imperial College of Science and Technology, "The Indian Silk Industry." The RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday afternoon, February 5th, PROFESSOR A. BERESFORD PITE, F.R.I.B.A., delivered the second lecture of his course on "Town Planning and Civic Architecture."

The lectures will be published in the *Journal* during the summer recess.

HOWARD LECTURES.

Professor William Ripper, D.Eng., D.Sc., having been appointed Vice-Chancellor of the University of Sheffield in place of Mr. H. A. L. Fisher, who has now become Minister of Education, will be unable to deliver the course of Howard Lectures on "Works Organisation and Efficiency" which have been announced in the *Journal* for April 23rd and 30th and May 7th. He will, however, read a paper on this subject at one of the Ordinary Meetings after Easter.

A course of two Howard Lectures will be delivered by Mr. William George Fearnsides, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, on "The National Shortage of Cheap Iron Ore Supplies" on Mondays, April 30th and May 7th, at 4 p.m. The lectures will deal with (1) "Available Home Supplies of Iron Ore"; and (2) "Overseas Iron Fields which Supply the British Market."

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 7th, 1917; SIR THOMAS BARLOW, Bt., K.C.V.O., M.D., F.R.C.P., LL.D., F.R.S., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Beaumont, Ivor, A.R.C.A., F.I.B.D., 74, Addison-way, Hampstead Garden Suburb, N.W.

Bebianno, Affonso, 858, Rua Barão de Mesquito, Rio de Janeiro, Brazil, South America.

Gaunt, Edgar Lawson, "Nethway," Horsforth, near Leeds.

Jones, George W., Gough-square, E.C.

Mervyn-Howell, William, 13, Cathedral-road, Cardiff; and 8, Essex-court, Temple, E.C.

Starr, David Alfred, Clyde Valley Electrical Power Company, 53, Bothwell-street, Glasgow.

The following candidates were balloted for and duly elected Fellows of the Society:—

Beale, Lieut.-Colonel W., c/o Thomas Cook and Son, Ludgate-circus, E.C.

Blades, Alfred, Messrs. Blades, East and Blades, 23, Abchurch-lane, E.C.

Burnett-Hurst, Professor Alexander Robert, Sydenham College of Commerce and Economics, University of Bombay, Bombay, India.

Dreer, William F., 2121, Garden-street, Santa Barbara, California, U.S.A.

Hazard, Frederick Rowland, Syracuse, New York, U.S.A.

Islington, The Right Hon. Lord, P.C., G.C.M.G., D.S.O., 8, Chesterfield-gardens, W.

Krishna, Siri, M.A., Ludhiana Ice Factory, Ludhiana, Punjab, India.

Kumar, Hukm Chand, B.A., D.A.V., High School, Quetta, Baluchistan, India.

McCrone, Robert, Haughbank House, Mauchline, Ayrshire, N.B.

Mackenzie, Lady Owen, 6, Chesham-street, S.W.

Ong Boon Tat, 29, South Canal-road, Singapore, Straits Settlements.

Reid, Sir Marshall Frederick, C.I.E., Woodcote Lodge, Epsom, Surrey.

Ring, John, 508, Merchants' Exchange, St. Louis, Missouri, U S.A.

Schuster, Professor Arthur, D.Sc., F.R.S., Yeldall, Twyford, Berks.

Sethi, Seth Mauekchand B. (Tazr-ul-Mulk), Gwalior, India.

Sheppard, William Didsbury, C.I.E., East India United Service Club, 16, St. James's-square, S.W.

Tabor, Frederick Richard, 3, Duke-street, Adelphi, W.C.

Tilston, Henry Edward, M.I.N.A., Calle Cangallo 499, Buenos Aires, Argentina, South America.

Waterlow, Edgar L., M.A., Messrs. Waterlow and Sons, Ltd., Great Winchester-street, E.C.

Wigglesworth, Edwin, 9, Carlton Mansions, Holland Park-gardens, W.

The paper read was—

THE FUTURE OF BRITISH SPAS.

By ROBERT FORTESCUE FOX, M.D.(Lond.), F.R.Met.S.

When more than two hundred years ago, and again a century later, Europe was ravaged by war, as it is now, the English spas were at the height of their prosperity. The memoirs of those times furnish an entertaining picture of Bath or Tunbridge Wells or Cheltenham thronged by the fashiona le world. Those who came for health and healthful recreation mingled with the gay throng who cared only for notor ety or display, and with others whose object it was to prick their jaded appetite for pleasure by a round of excitements and dissipations in a new scene. We may read of coaches and six taking the road for the waters, of beaux and belles alike disporting themselves in laces and satins, and carried in chairs to their rendezvous at the springs; and of celebrated beauties holding court whilst they completed their toilet or elegantly drank the morning draught. It would scarcely be just to hold the spas in any country responsible for the extravagances of manners that they witnessed. It was the custom in those times for the *beau monde* to gather at one or another of the English spas, just as later on in the Victorian age British invalids and health seekers in a more serious spirit resorted to the waters of Germany and France.

A great gulf is fixed between those earlier days and these. Men and manners have changed, but the waters go on. Another great European war has brought the British spas once more into the public eye, and this time not for fashion or idle display, but for the care and restoration of wounded men.

I propose in this paper first of all to ask your attention to some outstanding characters of the chief British spas. They do not form a large group in comparison with the spas of some other countries, but it should be possible now to indicate rather more definitely than heretofore the place which they hold, or should hold, amongst the health resorts of Europe. In this connection I shall notice some valuable British springs that appear to me to have been neglected.

Secondly, with your permission, I should like to place on record what has been accomplished during the past two years by means of waters and baths in this country for the treatment of soldiers.

Lastly, I propose to touch upon the new science which underlies and substantiates all treatment by means of waters and baths. I shall ask you to consider by what means this new branch of science can best be promoted.

A cursory review of the Br tish spas shows that several important types of medicinal water are represented in our country. First and foremost are the thermal waters, which flow from a considerable depth in the rocks, and have chemical and physical properties quite unlike other waters. The origin of these waters is a fascinating study. According to one theory, a thermal spring is a *new* or *nascent water*, formed by the combination of hydrogen and oxygen at a great depth in the earth's crust and at high temperatures. This may account for the fact that it differs from other waters in its solvent power and in its chemical and physical properties. The hot spring is described as an attenuated volcanic eruption. It often gathers salts in the more superficial strata through which it passes, but it brings to the surface from a great depth metals and metalloids and gases which are not met with in other springs; and its physical qualities include not only natural heat but electrical properties and radio-activity.

We have at Bath and Buxton valuable waters of this kind. Recent investigations into the properties of thermal waters should therefore be of much interest to us. Just as the old question used to be discussed whether saline water could be artificially reproduced, whether in short there was any real value in the natural product, so the same question was asked about thermal waters. Are thermal baths in any way different from water artificially heated? Five and twenty years ago, in a valuable book on British spas and climates, prepared under the auspices of the Royal Medical and Chirurgical Society, this question was raised by the late Dr. Ord. Dr. Ord thus expounded the doctrine of that time: "We take it that the idea that telluric heat has in itself any peculiar therapeutic value, and that water rendered hot by nature is in any different physical state from the same water artificially heated, cannot now be entertained." But, later on, speaking of the gases contained in thermal waters, he asks: "Is it possible that nitrogen dissolved in water and free from the opposition of oxygen may exert a sedative action on the surface of the body? Or is there, after all, something in this alleged telluric heat, conferring on nitrogen issuing in the thermal waters some new qualities, dependent on some allotropic change, which gives a special virtue to the baths?"

Not long after Dr. Ord wrote these words argon and helium, elements allied to nitrogen, were found in the waters of Buxton, and in 1898 came the discovery of radium. In due course many medicinal waters, and in particular those thermal waters which from their very insignificant content of mineral matter had long been known as "indifferent thermals," were found to contain these new elements and to be radio-active, sometimes to a remarkable extent. Fresh from the source, they show not only the energy of heat at a precise point of temperature, but this other elusive form of energy. And both are soon lost. The late Sir William Ramsay has given us a full account from the physical side of radio-activity in the waters of Bath. The properties of radio-activity on the medical side have not been as yet worked out, but there is reason to think that it is a factor in the action of certain medicinal waters.

Fruitful investigations have been commenced in another direction. It has been found that metals and metalloids are present in many waters in what is known as the colloidal condition. We now know that many active elements like arsenic, iron, sulphur, barium, copper, silver, zinc—even when present in extremely minute quantities in a colloidal condition—exert a power altogether out of proportion to their bulk—for example, in destroying micro-organisms or arresting their activity. It is now possible to observe with the ultramicroscope active particles of arsenic, sulphur and other elements in natural waters, and to measure the size of the particles and the speed of their movement.

It is sufficient only to name these two investigations in order to show that a door has been opened for further research. If we desire to understand medicinal waters we must know, not only what are their physical properties, such as heat, electricity, and radio-activity, but also what is their chemical constitution and the association or dissociation of their elements, and what elements are present in a colloidal condition. It is not difficult to believe that this new knowledge will in time account for the estimation in which many thermal waters have been held for two thousand years.

The waters of Bath are the most remarkable of their kind in Northern Europe. Their high temperature and abundant flow admirably adapt them for *thermal treatment*. Thermal treatment, strictly speaking, means subjecting the body to the action of natural thermal waters, with their various chemical and physical properties to which I have referred. It will be readily understood that thermal treatment is a two-edged weapon, and that it may produce either good or ill effects according to the skill with which it is handled. Baths must be dosed as accurately as drugs, and their effects as closely watched. In my opinion natural hot baths are more valuable than any others in the treatment of chronic disease.

All good thermal spas like Bath are very ancient. Hot springs are not easily overlooked, and they were most of them discovered by the Romans. But with all its merits antiquity has its drawbacks. I have often thought that it is sometimes rather difficult to keep an ancient spa up to date. Science advances, and time and men's needs are changed so rapidly that the appliances of a first-rate spa must needs be renewed almost from generation to generation. How shall this be done when the ground is cumbered with the relics of many centuries? It is necessary to let the ruins, however stately, stand aside, and let the ever-new water find a new habitation. In my belief the waters of Bath are a unique possession in England and worthy of the best setting that it is possible to give them.

Much that I have already said upon thermal springs applies as much to Buxton as to Bath. The two spas are, however, sharply contrasted in their relation to the temperature of the human body. Buxton water is some 15° below blood heat; Bath as much, or more, above blood heat. The difference of climate intensifies this contrast. Bath has a sedative and valley climate. Buxton, at an elevation of 1,000 ft., is the most tonic spa in the British Islands. It follows that for most people Bath is preferable in the colder months of the year, and Buxton in the summer; and it also follows that Bath is in our country the spa *par excellence* for thermal and hyperthermal actions, and that Buxton is equally well adapted by nature for what have been described as *subthermal* and tonic actions, which form so important a part in the treatment of invalids. I have already referred to the richness of the sky-blue water of Buxton in nitrogen gas and its congeners and in radio-activity. It also contains a number of metals, and would be an inviting field for the ultramicroscope. The waters of Matlock Bath are of the same class, but considerab.y cooler.

Another class of natural waters is composed of those that depend for their medicinal value chiefly upon the element sulphur. We have no hot or thermal sulphur springs like the famous New Zealand waters and those of the French Pyrenees, but the British Islands are rich in cold sulphur springs. Of these there are two kinds, which are called respectively the *pure* sulphur waters, such as those at Strathpeffer in Scotland, Llanwrtyd in Wales, and Lisdoonvarna in Ireland, and the *salt* sulphur waters, represented by Harrogate and Llandrindod Wells.

Harrogate is a spa of the first magnitude, both as regards the quality and number of its springs (about eighty in all) and the excellence of its equipment. I know no group of similar waters in any country more remarkable in number and variety than those which rise within the space of a few yards in the "Bog-field" at Harrogate. In these springs both sulphur and salines are present in varying proportions, so as to afford a variety of combinations, suitable for different forms, more particularly of gouty and rheumatic and digestive disorders. The climate of Harrogate is tonic and well suited in summer for delicate persons.

The waters of Strathpeffer contain but little saline matter, but are very strong in sulphur. They are therefore appropriate, where it is desired to obtain the uncomplicated effects of sulphur water, in internal or external application. The cool summer season in the northern latitude and the fine air of the North of Scotland no doubt contribute to their effect.

In addition to the spas that I have noticed, there are many less known sulphur waters in Britain. They abound in most counties. I wish to emphasise the importance of this particular class of spas. It would, I think, be hard to find in the whole range of medicinal waters an ingredient of so much remedial value as sulphur. This may seem a confident assertion. But it rests upon a large number of observations which I had an opportunity of making during many years at one of the smaller British sulphur spas. Many of the poor people and the farmer folk in the neighbouring counties suffered with rheumatism, and I was able to confirm beyond question their own statements as to the relief they obtained both from sulphur waters and baths. I also remarked that a large number of patients of a different class resorted to the same waters for gout and gouty ailments. Year by year experience showed that gouty as well as rheumatic disorders were definitely amenable to treatment by sulphur waters.

It is, therefore, a happy circumstance that in a country like ours, where rheumatic and gouty affections are especially prevalent, the provision of sulphur waters is so varied and extensive.

We now come to the British waters which are chiefly salt or saline. I have already mentioned that some of the sulphur waters contain a proportion of salt, which modifies their action. But quite apart from these wells of mixed constitution, the great class of salt waters in which table salt is the chief ingredient is well represented in Great Britain. There are, it is true, no hot or effervescing salt springs in our country, like those that have been so much used abroad in the form of baths, for disorders of the heart and circulation. I can only say here that the medical value of such baths, whether natural or artificially prepared, is in my opinion proven. A large number of persons affected with maladies of this kind can be treated with great advantage by hydrological remedies. The familiar "disordered action of the heart" of soldiers is a case in point. During the last six months this troublesome condition has been treated with good results by the sedative pool bath. Certain Continental spas with salt waters, like Nauheim, have in recent years become famous for the treatment of such disorders. It will be readily understood that in cases of this kind baths must be given with care and precision. No routine

treatment is admissible, and every case requires careful medical supervision at all stages. Such conditions cannot be guaranteed at every health resort. But I am confident that, given these necessary conditions, cases of disordered heart and circulation can be as well treated within the British Islands as at any Continental spa.

The British salt waters are cold, like those of Bex in Switzerland and Salsomaggiore and Kreuznach. They show a variety of composition, and are to be found in all grades of strength. The water, or rather the nearly concentrated brine, of Droitwich is drawn up from the deposits of what was probably once an inland sea or lagoon. Such brines are too strong for internal use, but furnish a powerful means of what is known as *surface treatment*. From their action upon the surface of the body they indirectly stimulate the deeper tissues, and produce a favourable reaction in certain chronic diseases. This principle and the practice founded upon it have been carried much further at foreign salt spas than with us. I will only refer to the Limans on the Crimean coast and to the Scandinavian spas. Weaker but valuable brines are available at Nantwich and Stafford. Salt waters of a potable strength are found at Woodhall Spa, containing other important ingredients, such as the chlorides of magnesium and calcium and also iodine. Llandrindod Wells and Leamington may be here mentioned, for although very different in other respects they are alike in one important matter. The saline strength or grade of both these spas, which are too little appreciated, happens to approximate very nearly to one per cent. This is the strength or *tonicity* of salt in the fluids of the living body. Therefore waters having a similar tonicity offer what has been called a "natural serum," and should be helpful in irritable conditions of catarrh of the mucous membranes.

Every spa physician has remarked the powerful influence of climate upon hydrological treatment, and especially upon the effects of baths. The same bath has very different effects, according as it is given in the summer time, let us say, in the Rhine Valley at Nauheim, beyond the Grampians at Strathpeffer, or at 5,000 ft. above the sea at Bormio. Spa treatment is everywhere modified by the local climatic conditions. It is, therefore, important to remember that the British spas are located in a tonic and invigorating island climate. All British health resorts are tonic, relatively to those of the Continent, and therefore as a rule the treatment is more invigorating than similar treatment taken abroad, and the need for an "after-cure," so often emphasised at the French and German resorts, is not so much felt. Within the shores of the British Islands there is, however, quite enough variety of climate to give some of the spas a more tonic and others a more sedative action, which is a matter of considerable practical importance. It is because, as a whole, the British spas are comparatively cool and bracing that they offer to our friends across the Channel, as was suggested some years ago by Dr. Neville Wood, not only an invigorating treatment but a pleasant and healthful change from the heat of the Continental summer. I have a vivid recollection of the interest manifested by parties of French physicians, who were conducted to some of the Scottish and English health resorts after the International Medical Congress in the year before the war. I know of no reason why the British spas should not become places of European resort. May I add here that experience both of British and Continental spas more and more shows the value, not only of large and highly-equipped establishments, but also of simpler and smaller spas? There is room for all. No health resort, however well provided, can meet the indications of all cases. On the other hand, there are some unpretentious places which offer few means of treatment, but they suffice for those that need them. Moreover, especially in the present days, rest is sometimes a necessary ingredient of the cure, and a restful spa is wanted. There are in Britain many small and restful spas, having active waters and good provision for baths. It would be a mistake to regard these places as in their own way less valuable than the larger health resorts.

Dr. S. Sunderland, in his book on the "Spas, Baths and Wells of Old London," has shown how common it has been for spas famous in their day to undergo a temporary or permanent eclipse. Many and various factors contribute to the reputation of a health resort. When from any cause this reputation has declined, it sometimes happens after many years that the waters are investigated and their merits brought to light. The spa is rediscovered, and established on a basis of more exact knowledge. No other foundation can of course be possible for an acceptable method of medical treatment, and, as we shall see immediately, there is nothing more desirable in regard to the British spas than a systematic determination of the scientific basis of the actions of waters and baths. Some spas have already undergone this process of redis-

covery with the advance of knowledge, and others will probably undergo it. It is not unlikely that some British waters of which little has been heard for many years will be again brought into use. Cheltenham has abundant springs of a mild saline water, which are well adapted to digestive and gouty disorders. One of these springs contains bicarbonate of soda, and is the only alkaline water in the British Islands with which I am acquainted. Bridge of Allan, again, possesses an unusual type of salt water, of which the density or tonicity closely corresponds to the fluids of the body. I should also anticipate a revival of the use of chalybeate waters, of which there are many in our country, not forgetting the once famous water of Tunbridge Wells.

Lastly, there is a British water different in kind from any of those already mentioned. It resembles certain much-frequented waters in the Vosges Mountains, and is very similar to that of Evian-les-Bains, on the Lake of Geneva. All these waters contain only very minute quantities of mineral constituents. Their whole action is not to bring matter into the body, but to dissolve and eliminate matter from the body. They are powerful solvents, and in these days, when toxic disease is so prevalent, natural solvent waters must have a place in the field of hydrological medicine. The increasing use and reputation of solvent waters on the Continent of Europe may well lead us to anticipate a similar development in the British Islands. The water which I have in mind does not stand alone in this country, but it is the chief of its kind. It is the St. Anne's Well at Malvern. In my opinion it is quite as efficacious as that of Evian-les-Bains. As we now know, all waters are most active fresh from the source. Bottled waters are second-rate at the best. I am disposed to think that there exist at Malvern all the necessary elements for a first-rank spa having these desirable properties. It is a water well adapted for all cases requiring eliminative treatment. I need not specify the various forms of illness in middle and later life for which solvent waters of this kind are prescribed. The Malvern Hills offer, in addition to the water, an air of bracing quality, which has been recently shown to be almost unrivalled for purity in England. The fine quality of the air has long been recognised, and the climate and beauty of the locality have long ago placed Malvern high in the rank of British health resorts. What I think remains to be recognised is the fact that the water is of such a kind as to give it a useful place among the British spas.

Soon after the war broke out a committee of the Royal Society of Medicine, in its Section of Balneology and Climatology, was appointed to inquire into the existing facilities for the treatment of soldiers at the British health resorts, and by physical methods in general, and to advise the War Office in the use of these facilities. Authoritative advices of a complete and deliberate nature were issued both to spa practitioners and to the staffs of military hospitals, which should serve as a guide to them in the employment of British waters and baths for soldiers, whether wounded in various ways or invalided from the Front. Local committees were formed in the health resorts, and case record cards were prepared and freely supplied for reporting the treatment of such cases upon a simple and uniform system.

At all the localities, from the beginning, every facility was freely placed at the disposal of the wounded. Local authorities and private owners vied with one another in this effort. The work of the committee has been rather confined to assisting in making better known the benefits that accrue from adequate treatment of this kind, to the selection and distribution of cases appropriate to different places, to recommending the provision of new and better methods of treatment, and to setting up for the first time in connection with the health resorts a proper system of case records. In some of these matters difficulties have naturally been encountered, and the work is still unfinished. At a recent meeting of the Royal Society of Medicine reports have been presented, and others have reached me direct from the spas, which give some idea of the magnitude of the work that is already being accomplished for the wounded. At Bath 2.220 soldiers have been treated by waters up to the middle of November. Even larger numbers (3,500 soldiers) have been received into the hospitals at Harrogate, but only a certain proportion of these have used the waters and baths, as some of the hospitals at Harrogate are devoted to acute cases. I may here say that it has seemed to the London committee that, considering the number of soldiers who really require spa treatment, it would be better, as a general rule, that the various hospitals at the spas, which are not too numerous, should be reserved for spa invalids, otherwise it may well be that men who urgently need treatment for stiff limbs, shell-shock, rapid heart, or rheumatism are kept out by surgical cases that might

as well be treated elsewhere. A recommendation to that effect was made to the Army medical authorities. At Buxton, in the first two years of the war, 1,926 men were treated in the Devonshire Hospital. At Buxton also a very interesting new departure has taken place in the erection by the Canadian Government of a special hospital for Canadians suffering from wounds and ailments requiring hydrological treatment—that is to say, the expert use of waters and baths and other physical remedies. I am informed that up to date 67 per cent. of the men treated in this manner have been returned fit for duty. At the salt baths of Droitwich, 17,102 free treatments have been given. Woodhall Spa, with limited accommodation, has treated 267 cases, and the Highland Moor Red Cross Spa Hospital at Llandrindod Wells 307 cases in fifteen months. Many other soldiers have been treated at Leamington and Cheltenham; and at Strathpeffer 150 cases of rheumatism and other ailments for which treatment by sulphur waters and baths is appropriate have been treated.

I may here mention that, altogether apart from the work at the mineral spas, there has been during the past two years a great increase of hydrological treatment in Great Britain and Ireland to meet the needs of wounded soldiers. A new form of local treatment by means of moving water at varying temperatures has been introduced into this country and greatly developed. "Whirlpool Baths," as they are now called, have been widely used for stiff and disabled limbs. Also a large "sedative pool bath" of flowing water has been devised for the treatment of disordered action of the heart and for shell-shock and nervous affections. And under the auspices of the same committee these local baths and sedative baths, and others of a more stimulating nature, have within the past year been installed in many places where wounded men are under treatment, including the Command Depots at Tipperary and at Heaton Park, near Manchester; at the Canadian Hospital at Ramsgate; and at the great Red Cross Hospital at Netley; and at Red Cross clinics in Brighton and London.

The use of these hydrological methods has already proved of much value, and under expert medical direction is likely to take an important place in the treatment of disabled soldiers.

Those who are acquainted with the British spas will acknowledge that some are already admirably utilised; whilst others, perhaps of equal merit, are capable of further development. Some, like Bristol Hot Springs and Scarborough Spa, belong to the past; some, I think, belong to the future. It is a matter of much satisfaction that good and solid war service has been accomplished during the last two years by means of remedial baths, combined as they should always be combined with other forms of physical treatment, not only at the spas but throughout the country. In these matters it is evident that a new development is taking place. In what direction, then, are we moving? Let me remind you of the natural evolution of the modern health resort. It began in the nineteenth century. Where in previous centuries only dignitaries and wealthy persons used to resort year by year with their great equipages, railways began to bring the people. The nineteenth century also witnessed everywhere a reaction from heroic methods of treatment, and all classes began to turn more and more, with instinctive confidence, to natural and physical remedies. At the spas, where there had been only tens and hundreds, scores of thousands of health seekers presented themselves; and not only at the spas, but wherever the use of water in any shape or form was set up. Many systems of treatment were bravely built upon the sands of ignorance, and unfortunately the lack of knowledge was badly compensated by excess of zeal.

Then, in the middle of the nineteenth century, two new sciences arose—it was high time—to join the large circle of sciences that are handmaids of medicine. These are to-day the two sciences of the health resort—climatology, which deals with the air, and hydrology, which deals with the water. I do not mean that those who had handled this form of practice in previous years were not endowed with much wisdom and long experience, but unfortunately for the most part their knowledge was an individual possession, and died with them. In the nineteenth century the facts began to crystallise out in a permanent form.

I have already incidentally mentioned some of the investigations that have been made into the properties of waters. Of even more fundamental importance are the researches of Winternitz and his pupils into the action of heat and cold upon the human body. If we are to use, as we are using, external surface treatments, we ought to know the effect, not only of temperature upon the body, but of salts and gases, and the effects of mechanical stimulation and movement. All these things are capable of exact determination. Hydrology deals with the

action and uses of waters of every kind, both within the body and external to the body, and since physical actions are exerted chiefly in the medium of water, these forms of treatment also come within its scope.

In Italy and France, Austria and Germany, during the last fifty years, this science has had many disciples, and has received the welcome to which all sciences are entitled. It is now taught in the universities of all these countries, in one form or another. In France there is one eminent Professor of Hydrology at the University of Toulouse, annual courses of lectures at other universities, and an Institute of Hydrology has now been attached to the Collége de France. In Germany facilities for this teaching are provided at ten or twelve of the universities. In Austria-Hungary there are professors of "Hydrotherapy," or "Balneology," at Vienna and Prague, besides lecturers in other universities. Italy has systematic teaching in at least five universities, and a professor at Rome.

On July 21st, 1914, a few days before the outbreak of war, a memorial was laid before the University of London, recommending the establishment of a University Chair in Medical Hydrology and Medical Climatology. That proposal is still before the Senate. Those who were responsible for it believed that London, as the capital of an Empire rich in climatic resorts and in medicinal waters, was the natural centre for the proposed teaching. They knew that one of the aims of the University of London was to supply means for instruction and research in subjects that are not dealt with in the individual schools. They held that, taken together, these subjects form a branch of medicine of such importance that it ought to be systematically taught; that the absence of proper teaching in medical subjects was the source of many evils, and opened a wide door for empirical and irregular practice. They therefore proposed that a Chair should be established in London, and that authoritative teaching should be thereby provided for senior students and practitioners who were likely to specialise in this branch of practice, as well as for medical men who came from the country or from distant parts of the Empire; and also that laboratory facilities be provided for research work upon British soil. The memorialists pointed out that in this country alone the student and practitioner are without any means of special instruction and research, and called attention to the fact that in India, South Africa, Australia, Canada and New Zealand there are large numbers of waters and climates of the first importance awaiting scientific study and recognition.

These considerations appear to have gained weight and force from the experience of the war. I have alluded to the use of physical remedies for soldiers. They will probably be much more extensively employed. These are highly-specialised forms of treatment. Where are the specialists? The need is not met by setting up a "whirlpool bath," valuable though that may be for a disabled limb. It is the worst error in physical treatment to think that one method is applicable to all conditions. We want trained men who have studied the principles and practice of hydrological medicine.

Again, what will be the effects of the war upon British spas? Quite apart from wounded soldiers, a new and great demand will be made upon them. The tide of British invalids and health seekers that has set for so many years to the Continent has been turned back. To what extent can the spas of the British Islands meet this new demand? As a physician I am only interested in the scientific side of these problems, but it is difficult to resist the conclusion that the case for teaching put forward two and a half years ago has become, if anything, more urgent. It must be confessed that physical remedies are too little understood and therefore too often misapplied. Is it not obvious that no branch of medical science, or the art that is dependent upon it, can be in a healthy condition if it is not taught? I venture to go further, and say that it cannot be in the public interest that any form of medical treatment should be practised unless its elements are taught. I would submit that in this field science and practice have been far too much divorced. They should go hand in hand. May we not hope that the time has now come to lay the foundations of a British School of Hydrology, which shall embrace in its scope not only the British Islands but the Empire at large?

DISCUSSION.

THE CHAIRMAN (Sir Thomas Barlow, Bt., K.C.V.O., M.D., F.R.C.P., LL.D., F.R.S.), in opening the discussion, thought everyone would agree that the Society had done well in taking up the subject of British mineral waters as a definite asset of the Empire. Anyone who took the trouble to glance over a geological map of these islands would be struck with the fact that, in coming down from the north-west of Scotland to the south-eastern part of England the outcrop of almost every geological formation was present, and that in itself was an index of the enormous wealth of mineral constituents that lay at our doors, especially in

the form of mineral springs. The war, and what would follow the war, helped to accentuate the need of our becoming acquainted with this great inheritance. Not only in that but in many other ways the people of this country had been far too idle in realising for themselves what an extraordinarily rich country they lived in, which would respond to knowledge, to investigation, and to courage in a way that was quite remarkable. The author had envisaged the subject in a fundamental manner; he had drawn attention to the variety and richness of the mineral waters, and also to the remarkable variety of climate that the British Isles possessed. So far as the practical use of mineral waters was concerned, he desired to call attention to the wonderful coast-line that the British Islands possessed, which afforded such splendid opportunities for subsequent recuperative methods after the use of saline waters.

Mr. H. H. Spiller (Messrs. Thos. Cook & Son) thought the information contained in the paper would be a guide to the medical profession generally in connection with the different spas which were suitable for various complaints, and might lead to specialists living at the spas who were specially trained for the treatment of the diseases dealt with. One weak point connected with the spas of this country was that they were not carried on seriously apart from the professional branch. There ought to be more co-operation between the municipalities, the hotel-keepers and the professional men who were doing their best to establish the reputation of any particular spa. At the most renowned Continental spas the patient at once went to the doctor, who drew up a paper giving particulars of the treatment and *régime*, and those particulars were communicated to the authorities who ran the baths and to the hotel proprietors. Instead of having one *table d'hôte* in the hotel for everybody. there was a general *table d'hôte* for the people who were not invalids, and a special table for each of two, three or four particular treatments that were being undergone by different patients. In this country, on the other hand, we seemed to cater only for the general traveller, the tourist and the tripper. When an invalid went to a hotel he was looked upon as an individual who required more attention than other people, and was consequently charged more. That did not encourage patients to go to those places. If the medical profession took the trouble to recommend particular spas to their patients, and specialists were there for the treatment of the different complaints, he thought they ought to be more supported by the hotel people in the town, with the endeavour to attain their object—namely, the cure of different diseases and an increase in the number of visitors.

Mr. John Hatton (Director of the Baths, Bath) thought that in the future spa treatment would become more and more scientific. Research work would be carried out, like Sir William Ramsay's investigations into the radio-activity of the Bath waters, and like the work which he believed was being carried out in connection with the Harrogate springs, so that more would be discovered about mineral waters. Side by side with that, pathological research would be carried on; the range of diseases successfully treated by mineral waters would be widened, and the technique of administering the treatments would be still further improved. Much had been done on those lines already, and the leading spas now possessed highly trained and thoroughly efficient staffs of attendants and masseurs. By those means the percentage of successful cases and cures would be increased, confidence in spa treatment would be strengthened, and British doctors would realise that their patients could get quite as effective treatment at British spas as at the once fashionable German resorts. People had been driven to realise during the past two years that the springs of this country could cure them as effectively as—in many cases more effectively than—the foreign waters, and thousands of men had come to appreciate the value of spa treatment who had hardly heard of it before. In the second place the British spas would widen the field from which they drew their visitors. They would cater for French and Russian visitors to a greater extent than before; it looked as if American visitors would prefer British to German waters, and a growing number of guests would be welcomed from the Overseas Dominions. He hoped the combination of British spas which had recently been started would continue, and by combined advertising make a strong concerted effort after the war to attract foreign visitors. If that were done thousands of pounds would be brought into this country, as some of the German spas had in the past almost entirely been supported by British and Russian visitors. In each place the municipality, the hotels, the apartment houses, the amusement caterers, the shopkeepers and other business people, and certainly the medical profession, must realise that they were all in it for the general good of the place, that their success depended upon the success of the spa, and the success of the spa depended upon them. From the national point of view he thought British spas generally would realise that by combined effort in many directions they could accomplish work of real value not only to themselves but to the whole country.

Dr. W. Bezly Thorne said he could look back on the time when, with the exception of a perfunctory attempt to give some instruction in gynæcology, there were no special departments in the general hospitals of England. Little by little the hospitals had added departments for the eye, the throat, the ear, for dentistry, for the application of electricity, for pharmacology, and the study of bacteriology; but there was no single systematised instruction in hydrotherapy, or any installation in the hospitals upon which the first elements of that

science could be taught. There was no body of men in the world more highly cultured, better educated, and more devoted to the execution of their responsibilities than the medical profession in England; but to a very large proportion of them hydrotherapy was a closed book. That was an immense misfortune at any time, especially at present, when thousands of gallant men were returning home from the war broken in health, worn out in mind and with shattered nervous systems. Hydrotherapy covered a range of diseases and of affections such as none other of the specialisations could attempt to touch in number and application. Hydrotherapy would influence the course of all the specific fevers, especially those to which childhood was prone; it had a paramount influence over all those chronic affections which were classed as gout and rheumatism; it was the pre-eminent remedy for affections of the heart and the blood vessels, and for that hydra-headed and distressing class of affections classified under the name of "neurasthenia," which apparently some people in the present day wished to attribute entirely to psychic causes, although they were due to physical and toxic causes. It was difficult to realise the extent to which that state of ignorance on the subject of hydrotherapy operated at the present time. In his opinion there should be no general hospital or institution for the education of medical men without systematised instruction in hydrotherapy, and an installation by means of which the principles of hydrotherapy could be put into practice and administered for successive generations of rising medical men. Those institutions and installations should not in any way compete with the excellent spa establishments, but they should educate medical men in the range of application of hydrotherapy and how to select the cases. By such means hydrotherapy would be raised to the level of a science, and British spas would come into their own and enjoy that appreciation and patronage which they so well deserved. After twenty or twenty-five years' experience of hydrotherapy, and knowing something of both foreign and British spas, he could not think of a single affection which yielded to hydrotherapy which could not be as well treated in the British Isles as it could be abroad.

Dr. J. Campbell McClure said that his recent experience in connection with hydrotherapeutic work in the Army had proved that those who dealt with the subject had to fight against the ignorance of the average practitioner of medicine, whether civil or military, and the ignorance of those in authority on anything connected with hydrotherapy. That was not the fault of each particular individual authority or practitioner of medicine, but of the system, and it seemed to him it must speedily be corrected if the country was properly to develop along scientific lines. Systematic teaching of hydrotherapy must be established, because hydrotherapeutic methods were not mere playthings. Properly applied, they did an infinite amount of good; improperly applied, they did an infinite amount of harm. He had come across cases recently which had been handled badly in institutions which professed to supply therapeutic treatment, with the result that the country had probably lost good officers for a long time, and perhaps permanently. Hydropathic installations were being placed in the care of excellent men, but men who, until the time of their appointment, did not know one end of a bath from the other from a medical point of view. A very close co-operation between the municipality and the medical profession was absolutely necessary for the proper development of the spas. Just as education was necessary for the medical profession, in a far greater degree was it necessary for the municipalities. They were ignorant of the fundamental principles of medical practice, with the result that a great many health resorts in this country, spa or climatic, were rendered ridiculous by the amusements provided by the municipality for the entertainment of their visitors. There was no attempt—as in German, Austrian, French or Italian spas—to make the place attractive and yet at the same time keep it definitely therapeutic. It was possible to learn in that respect, as in many others, from Germany. German municipalities had the sense to be advised by scientific men, and just in so far as the municipalities of this country carried on their present independent Gadarene course, so the British health resorts would utterly fail.

Mr. J. H. Hollyer (Droitwich) said that, as the lay director of one of the baths at Droitwich, he much appreciated the opportunity of hearing what their medical friends, to whom they always looked for a lead, had to say on the subject of hydrology and the general treatment at spas. Much would be gained by still greater co-operation between the medical men and those responsible for the direction of the spas. He was glad to hear that the medical profession was about to give more attention to advisory matters in connection with spa treatment than had been given in the past. There were many medical men who knew that spa treatment effected certain results in particular cases, but they did not know the action or the nature of the particular baths, and cases were sometimes sent to spas where it was impossible to carry out the prescription of the doctor that had sent the patient. Those responsible for the lay direction would therefore much appreciate the effort which medical men intended to make to educate themselves in spa treatment. It was also urgently necessary that there should be closer co-operation than there had been in the past between the hotel proprietors and those responsible for the management of the spas, so that the treatment could be properly carried out. By that co-operation not only would the medical men gain by the better results which would be obtained, but the owners of the spas would also profit.

DR. M. O. ATKINSON (Leamington) said that he represented both the medical profession and the municipality, as he happened to be the Mayor of Leamington. Mr. Spiller's remarks were absolutely true, that as a rule the municipality knew nothing whatever about the baths. They ran them as a sort of mercantile enterprise. He was sorry to say, however, that the doctors were nearly as ignorant. If a doctor tried to run a spa properly he was immediately sat upon by his brother practitioners because they thought he was trying to benefit himself. It was high time that some sort of system should be adopted, but it was difficult to know what to do. One doctor recommended one particular system and another doctor the exact opposite. He hoped the balneological section of the Royal Society of Medicine would endeavour to arrange for the proper *régime* that should be adopted at each class of bath.

MR. CARMICHAEL THOMAS thought the reason British spas were not places of European resort was that they did not advertise as the Continental spas did. All over the Continent and England most charming advertisements were to be seen of Evian-les-Bains, with the result that people flocked there. If English spas desired to make themselves popular, the best way of doing so was continuously to advertise.

CAPTAIN M. DALE though it was necessary for the doctors at British spas to obtain more power than they at present possessed. At Carlsbad, for instance, the doctor did not hesitate to go into the hotel and investigate the patient's food if he had not been making satisfactory progress. That was not sufficiently done in the hotels at the spas in England. The hotel proprietors in this country wanted the patients to take the ordinary *table d'hôte* meals, and do the thing properly for the benefit of the hotel, to the detriment of the patients. The reason so many people went abroad was because they wanted to get the benefit of the treatment, and because they got better treatment abroad than in England. A German doctor told him that English people made the best patients in the world, because they did what the doctor told them, but they could not do so in England because of the hotel proprietor.

MR. HENRY D. ROBERTS (Brighton) said he desired to say a word in defence of the municipalities. It must not be forgotten that at most Continental spas there was a tax, which yielded a considerable revenue to the town. If Brighton taxed every visitor 1*s*. a large sum of money would be obtained to advertise the town. It was no use, however, advertising a town unless the visitors had something to interest them when they got there, and one of the reasons that German spas had been so popular in the past was that, in addition to the spa itself, there were other attractions, such, for instance, as the wonderful opera house at Wiesbaden. It must also be remembered that spas were an accessory to the town, and that the town was not an accessory to the spa. Although Droitwich possessed baths by means of which people were cured of diseases, it was also the centre of the salt industry, and made its living out of that. The fact that there were spas in a town sometimes made people lose a sense of their due proportion; they thought that, because the springs existed, all other interests must be put aside. The healing side in those cases was more or less of a side line in the actual business of the town, and people had to make their living in other directions. He was sure that the municipalities would, if they were approached, be only too pleased to co-operate with the doctors. If, as a result of the meeting, the doctors could get in touch with the recently formed British Association of Health Resorts, some good would, he thought, result. It was necessary that action should immediately be taken, because the spas on the Continent were at the present time issuing millions of pamphlets with the object of drawing people from this country to their spas after the war.

MR. E. J. BURROW (Cheltenham) said that Cheltenham was a most extraordinary example of a spa not being taken seriously. When war broke out the Corporation did not take the matter up properly, and a body of tradesmen thereupon subscribed about £2,000, so that the spa could be run. They actually went so far as to furnish the spa and to supply a band. Some of the doctors in Cheltenham did not believe in the waters. For a long time he suffered from colitis, and on asking the doctor if he should try the Cheltenham water he said, "You can if you like." As a matter of fact, it cured him. He told the doctor, who was quite pleased, but he knew nothing of its action. He thought the author had taken a right step in trying to get the medical profession to take the matter up seriously.

DR. G. V. WORTHINGTON (Llandrindod Wells) said he felt that some doctors had been accused a little unjustly of ignorance. There were many medical men at spas who had made a special study of the subject, but a large number of patients were sent to the spas each year by medical men who had sometimes never been near the spa. Those patients went on for some time with the treatment that had been prescribed, and, finding it unsatisfactory, they blamed the medical man. The ignorance existed in the medical men who sent the patients to the spa, and not so much among the medical men who actually practised at the spa. Municipalities were also to a certain extent ignorant, but at Harrogate and Bath the municipalities were doing all they could to co-operate with the medical men to make the spas successful. Attention had been called to the fact that in nearly all Continental spas a tax was imposed, and in some cases in Germany the Government directly subsidised or supported the spas. In England there was no such encouragement

at all; the spas got on as best they could. Big places like Bath and Harrogate had more or less ample funds, but the smaller places were greatly handicapped, and it was difficult for them to spend much in advertising. If some special facilities were granted by the Government, he thought British spas would be able to do quite as well as Continental spas. He welcomed the prospect of the establishment of a Chair of Hydrology at London University, so that men who practised at the spas would be able to learn their work well. At all spas there were a certain number of medical men who came to the place without any previous knowledge; they did not take the trouble to go abroad and make a special study of the work before they began practice, and many patients no doubt suffered at their hands. On the other hand, there were at all spas a number of men who had taken the trouble to learn; they paid periodical visits to the spas abroad for the purpose of learning anything new and taking the utmost advantage of it, so that it ought not to go out from the meeting that people going to British spas could not be properly treated. At some of the bigger spas where the hotels had large numbers of visitors, the hotels did not pay much attention to the diet that was ordered for particular patients, but all the hotels at Llandrindod Wells undertook to carry out any diet that the medical men prescribed. In a great many cases, if the patients looked into their own consciences, it was more their own fault than the fault of the spa they went to if they did not benefit, because they disregarded the doctor's instructions in regard to the diet that should be taken. If the German and Austrian Continental spa business was to be captured, now was the time to do it; but unfortunately at the present moment the railway facilities had been greatly reduced. Previous to the recent alterations, a through carriage ran from Euston to Llandrindod Wells in five hours, but at the present time there was only one train a day from Euston, which took ten hours and involved three changes. At a conference recently held of the six chief spas the Board of Trade was urged to give reasonable railway facilities to them with a view to capturing enemy trade, and unless that was done not much progress would be made.

Mr. J. H. Hollyer endorsed Dr. Worthington's remark that the members of the medical profession at the spas themselves most conscientiously devoted themselves to the treatment of their patients. When he previously referred to the ignorance of medical men, he referred to those practitioners at a distance who did not know anything of the nature of the spas to which they sent patients, and thereby created the difficulties to which he referred.

Dr. W. Bezly Thorne said he also desired to add to his previous remarks that all honour was due to those medical men attached to the spas for the knowledge that they had acquired through their own personal study and observation.

On the motion of the Chairman, a hearty vote of thanks was accorded to Dr. Fox for his interesting and instructive paper.

Dr. Fox, in reply, after thanking the Society for giving him the opportunity of reading the paper, which had led to such a frank and useful discussion, and the Chairman for presiding over the meeting, said he had been greatly interested in Dr. Bezly Thorne's remarks with regard to the growth of special departments. He looked upon the branch of study with which he had dealt in his paper as a special department. Medical men at large could not be intimately and closely acquainted with the action of waters of baths, and the subject must be administered by specialists. It could be said with pride that British medical men held a distinguished place so far as their knowledge of the science of medicine and surgery was concerned amongst their colleagues in all countries, but it could not be gainsaid that the special branch with which he had dealt still awaited adequate cultivation. The war had brought into startling relief the necessity for the administration of hydrological treatment, and, unfortunately, knowledge of that subject was not widely possessed by the profession at large.

The meeting then terminated.

OBITUARY.

George James Drummond.—Mr. George James Drummond, who had been a member of the Society since 1868, died on January 31st, at his house at Penshurst, in his eighty-second year. His family has been connected with the Society since the year 1757, when Robert Drummond, a partner in the well-known banking house, was elected. The bank was founded in 1707 by Andrew Drummond, the father of Robert and John Drummond, the latter of whom joined the Society in 1762. The connection between the family and the Society has been continued from 1757—three years after its foundation—up to the present time. At the time of his death Mr. George Drummond was the senior partner in the firm.

In the year 1716 the Adelphi estate was sold by Sir Thomas Monpesson to the trustees of the will of Sir John Werden, who had two daughters—one of them, Lucy, married Charles, the second Duke of St. Albans, and the other, Charlotte, his brother Lord William Beauclerk. The third Duke's trustees granted a lease to the brothers Adam, who built the Adelphi and gave it its well-known name. John Drummond married a daughter of Lord William Beauclerk, and the Adelphi estate was devised to her by her nephew the fourth Duke (the son of Lord William Beauclerk). By this means the estate

came into the possession of the Drummond family. From John's son George, the estate passed to his son, his grandson, and his great-grandson George James Drummond. The original lease of the Society's premises terminated in 1867, and since that date Mr. George James Drummond has been the owner of the estate and the landlord of the Society.

COLONEL THOMAS HOLBEIN HENDLEY, C.I.E., L.R.C.P., M.R.C.S.—Colonel Thomas Holbein Hendley died at his residence in St. John's Wood on the 2nd inst., in his seventieth year.

He received his medical training at St. Bartholomew's Hospital, where he was Gold Medallist, and entered the Indian Medical Service in 1869. The greater part of his time was spent in the Rajputana State, and he was for twenty-four years Residency Surgeon at Jaipur. In 1897 he was Inspector-General of Civil Hospitals in the United Provinces, and from the following year until his retirement in 1903 he filled the Permanent Inspectorship in Bengal. He took a deep interest in the Ambulance Association of St. John of Jerusalem, of which Order he was a Knight of the Cross. He was also an ardent Volunteer officer. He was also widely known for his labours for Indian art. He organised the Jaipur Exhibition, and afterwards the excellent and well-planned Jaipur Museum. He wrote a number of works on Indian Art and History, including "Memorials of the Jaipur Exhibition" (four volumes), "Alwar and its Art Treasures," "Damascene Work in India," and "Rulers of India and Chiefs of Rajputana"; he was one of the originators of the *Quarterly Journal of Indian Art*.

Although Colonel Hendley only joined the Royal Society of Arts in 1916, he had for many years been interested in the work of the Indian Section. His first appearance here was in 1892, when he took part in the discussion on Sir William Moore's paper on Indian Sanitation, and from that time onwards he continued to speak at meetings or to contribute letters to the *Journal*. In 1914 he read before the Section a paper on "Indian Museums: A Centenary Retrospect," for which he received the Society's Silver Medal.

MEETINGS OF THE SOCIETY

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

FEBRUARY 14.—LAWRENCE CHUBB, Secretary to the Commons and Footpaths Preservation Society, "Highways and Byways." The RIGHT HON. LORD FARRER will preside.

FEBRUARY 21.—MRS. C. HOSTER, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment." LADY EMMOTT will preside.

FEBRUARY 28.—FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs." ROBERT HUTCHISON, M.D., F.R.C.P., will preside.

MARCH 7.—JAMES HARRIS VICKERY, LL.B., "German Business Methods."

MARCH 14.—DR. J. AUGUSTUS VOELCKER, "Fertilisers and their Supply in War Time."

MARCH 21.—G. W. JONES, "Colour Printing and some Recent Developments." CARMICHAEL THOMAS, Chairman of the *Graphic* and *Daily Graphic*, will preside.

APRIL 18. — HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

APRIL 25.—SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

FEBRUARY 15. — PROFESSOR H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S., Imperial College of Science and Technology, "The Indian Silk Industry." The RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

MARCH 15.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

APRIL 19.—D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

MAY 17.—SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

FEBRUARY 27. — ALFRED BIGLAND, M.P., "Imperial Assets and how to use them."

MARCH 27.—The HON. FREDERICK W. YOUNG, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee,

Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

GABRIEL GORDON CLEATHER, "The Drum."

DR. M. HORN, "The Belgian Colonies."

PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency."

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

Syllabus.

LECTURE III.—FEBRUARY 12.—*The Nineteenth Century.* Paris under the Empire. Vienna—Ringstrasse and buildings. Berlin—Centre and growth. Washington, New York, and Chicago. England—Late Georgian and Victorian progress.

LECTURE IV.—FEBRUARY 19.—*The Housing and Town Planning Act,* 1909. Problems for solution. Procedure. Advice to promoters. Preparation of schemes. Architectural considerations. Examples of Garden City movements—Letchworth, Hampstead, etc. The problem of London.

HOWARD LECTURES.

Monday afternoons, at 4 p.m.:—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies: (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market." Two Lectures.

April 30, May 7.

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m.:—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 5, 12, 19.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Professor A. Beresford Pite, "Town Planning and Civic Architecture." (Lecture III.)

Brewing, Institute of (London Section), at the Birkbeck Restaurant, High Holborn, W.C., 7.30 p.m. Discussion on "The Season's Barley and Malts."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. E. Savill, "The Defence of the Realm (Acquisition of Land) Act."

Electrical Engineers, Institution of (Local Section), Mining Institution, Newcastle, 6.45 p.m. Discussion on "The Metric System."

TUESDAY, FEBRUARY 13... Cyclists' Touring Club (Metropolitan District Association), at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.15 p.m. Annual Meeting.
8.15 p.m. Illustrated Lecture.

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Miss M. A. Czaplicka, "On the Track of the Tungus."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Pain and its Nervous Basis." (Lecture V.)

Photographic Society, 35, Russell-square, W.C., 8 p.m. Annual General Meeting.

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. The Right Hon. Andrew Fisher, "Australia—a Commonwealth."

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7 p.m. Mr. R. Townend, "Frequency Changers."

Heating and Ventilating Engineers, Holborn Restaurant, W.C., 5.30 p.m. Mr. A. H. Barker, "Standard Methods of Testing No. 1."

WEDNESDAY, FEBRUARY 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. Lawrence W. Chubb, "Highways and Byways."

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. L. Martineau, "Hydraulic Transmission."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Colonel S. A. M. Copeman, M.D., "The Prevention and Arrest of Infectious Disease in War Time."

Oriental Studies, School of, London Institution, Finsbury-circus, E.C., 5 p.m. Mr. L. D. Barnett, "Ancient India."

THURSDAY, FEBRUARY 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Professor H. Maxwell-Lefroy, "The Indian Silk Industry."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. Mr. J. H. Owen, "The Home Life of the Sparrow-Hawk."

Chemical Society, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor F. G. Donnan, "The Mechanism of Chemical Change." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. D. J. Cassavetti, "Greece and the European War."

Historical Society, 22, Russell-square, W.C., 5 p.m. Anniversary Meeting.

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. 1. Mr. H. W. Hutchin, "The Wet Assay of Tin Concentrate." 2. Mr. J. J. Garrard, "Hydraulic Tin Mining in Swaziland."

FRIDAY, FEBRUARY 16...Royal Institution, Albemarle-street, W., 5.30 p.m. Very Rev. H. H. Henson, "Author's Dedications in the XVIIth Century."

Electrical Engineers, Institution of (Scottish Section), 207, Bath-street, Glasgow, 7.30 p.m. Dr. A. Russell, "Some Aspects of Lord Kelvin's Life and Work."

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Dr. W. Mason, "Alternating Stress Experiments."

SATURDAY, FEBRUARY 17...Royal Institution, Albemarle-street, W., 3 p.m. Dr. H. W. Davies, "The Mystery of Counterpoint." (Lecture III.)

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FRIDAY, FEBRUARY 16, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 19th, at 4.30 p.m. (Cantor Lecture.) PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." (Lecture IV.)

WEDNESDAY, FEBRUARY 21st, at 4.30 p.m. (Ordinary Meeting.) MRS. C. HOSTER, Hon. Secretary, Society for Promoting the Employment of Women, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment." LADY EMMOTT will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday afternoon, February 12th, PROFESSOR A. BERESFORD PITE, F.R.I.B.A., delivered the third lecture of his course on "Town Planning and Civic Architecture."

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, February 15th; The RIGHT HON. LORD ISLINGTON, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, in the chair. A paper on "The Indian Silk Industry" was read by PROFESSOR H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S., Imperial College of Science and Technology.

The paper and discussion will be published in a subsequent number of the *Journal.*

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and can be obtained by Fellows on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, January 30th, 1917; The RIGHT HON. SIR JOSEPH GEORGE WARD, Bt., K.C.M.G., in the chair.

THE SECRETARY of the Section stated that all present were doubtless aware of the sad cause which prevented the Secretary of State for the Colonies, Mr. Walter Long, from fulfilling his promise to preside at the meeting. Sir Joseph Ward, the distinguished ex-Prime Minister of New Zealand, had very kindly consented to take Mr. Long's place.

THE CHAIRMAN, in introducing the reader of the paper, said there was no one more qualified to speak on the subject of Imperial industries after the war than Mr. Beale. In Australia he was recognised as one of the most enterprising men in the Commonwealth, and anything Mr. Beale had to say on the question could be accepted by everyone. In amplification of what the Secretary had said concerning Mr. Long, he was sure everyone would sympathise with him and his family in the great loss they had sustained. His son went down leading his regiment, fighting in a noble cause. Nevertheless, those who fell by the way created a void in the life of their families that probably could never be filled, and it would be some satisfaction to Mr. Long and his family to know that the sad cause of his absence was deeply felt by all those present. He would personally take the opportunity of conveying to him what he felt to be the expression of the feelings of the meeting.

The paper read was—

IMPERIAL INDUSTRIES AFTER THE WAR.

By OCTAVIUS C. BEALE,
Representative and Past President of the Australian Associated Chambers of Manufacture.

A worthy padre tells the following anecdote: "Mortally wounded at the Somme, a British Tommy wrote to me this last message: 'With a good heart I die for England.' When I first

knew that boy he was shoeless and his clothing hung in rags." An everyday commonplace story, glorified by the admirable patriotism and adorable self-sacrifice of the young man. But the story illustrates also diabolised or apotheosised *laissez-faire*, just as our individual politics may cause us to regard it. Some of us declare, whilst others deny, that it is the duty of the State to make sure of provision for all honest citizens—to see that each shall have opportunity to earn an income. Was justice done to that boy and his like before the war? And when it is over are we to revert to like conditions as being everyday and commonplace?

Several years ago a prolonged discussion, occupying three days, upon the question of Imperial Preference took place at a Congress of Chambers of Commerce and of Manufactures of the Empire held in London. The manufacturers of Canada pronounced themselves in favour of Preference, which necessarily involves tariff differentiation. The venerable Lord Avebury—since departed—in speaking against it, said that a great advantage which the children of the poor enjoyed in England, as compared with those of Canada, was that under the English system of free imports the food and clothing of the children were obtainable at the lowest possible prices. It fell to my lot to follow him, in speaking for the other side. I was able to say that, having visited all the Provinces of the Great Dominion, I had not seen one shoeless, half-clothed or half-fed child, for the reason that the avowed policy and practice of the governing powers are to see that their citizens be adequately protected in every form through life. Further, if the kindly nobleman, whom we all held in honour, would accompany me I would find him a hundred thousand children within a three-mile radius from Cannon Street insufficiently clothed and fed. The statement of the best-informed man in the United Kingdom—Mr. Charles Booth—that four millions of the people were submerged into starvation had never been refuted.

Well, then, the war has come to end or to extend that state of things. With all our troubles, it looks as if the whole people in the interim are as well, and even better, fed and clothed than they were before. We find huge workhouses, so-called, transformed into military hospitals, whilst the former inmates, we are told, have returned for the most part to real work and with very satisfying remuneration. Once more at the parting of the ways, the Mother Country must make a decision to protect or to neglect. All that is worth having is worth protecting. Nothing that is worth having may be neglected.

The phrase "Political Economy," so prolific in mischief to mankind, was used for the first time by Mountchrestien de Watteville in 1615. François Quesnay and his friends long after adopted and spread its use. Quesnay, in overhaste for celebrity, announced his discovery of the quadrature of the circle. It was a trifling solecism compared with that involved in the jumbled concept "Political Economy" itself. As we can have "household laws" (*oikos* and *nomos* = economy), so logically we can have national economy without overstraining the simple idea. And much of the enormous mercantile, manufacturing and maritime success of the Germans is due to the clear-sighted men Friedrich List, Gustav Schmoller and their co-workers, who threw overboard the fetish so worshipped in England, to establish in its place the sound principle of *Volkswirthschaft*. The only equivalent is our word "protection" in its widest meaning. In periphrase it means conservation of national interests, than which there is nothing more loyal and laudable. But that is in deadly opposition to *laissez-faire*, which phrase M. Yves Guyot declares to be "the first formula of political economy," the other exponents being in full agreement.

The late lamented William McKinley, a true lover of his country, only a week before his cruel death, said that during his Presidentship no foreigner could claim he was better off because of McKinley's fiscal policy, and no American citizen could say that he was himself worse off. From the American standpoint of isolation, that was a just and loyal claim. It is their traditional policy to take all they can, as a Government, and give nothing—quite defensible and very much defended. Our case is altogether different, for we have been fighting rapacious enemies by co-operating with true and tried friends, who with us have risked all for the common life and hope.

All that we owe to neutrals must be paid for in cash, for beyond humanity and friendship there is no more obligation to any of them than that implied in the succinct speech of President McKinley. Nothing venture, nothing have: whilst inversely our duty is to those who have ventured their all with and for ourselves. That is justice itself, and justice exalteth a nation.

It remains, then, to indicate in what ways we can and must assist, by forming a column

of mutual strength and support, the British family of nations and our glorious Allies.

Not merely the inconceivable losses brought upon the Allies by the great war, but the incalculable cost of restoration and the burden of pensions, added to the vast indebtedness that will be incurred hereafter by indispensable imports from neutrals at exorbitant prices, impel us to associate for the common relief. No indemnities that may be inflicted upon our enemies will suffice to recoup us. The most that can be obtained will be interest at a low rate upon the principal sum. The bill will be passed on to their posterity and our own.

The Illustration of Sugar.

But immediate help and strength will be found in development by each member of the Alliance of its productive powers, especially in what are loosely called raw products. Most of these are in themselves manufactured goods, yet they become, for the use of others, manufacturers' materials. Of such, one of the most important and illustrative is sugar. We may best study it in relation to the United Kingdom itself. And here let me say that there will be no attempt to treat this or any other item exhaustively, but rather to seek, by displaying concrete examples, to set forth the principle and effect of preferential Allied interchange.

The United Kingdom requires at least 2,000,000 tons of sugar per annum, and much more if her sugar-using industries are to be developed as they ought. Of these 2,000,000 tons, 1,300,000 came from Germany and Austria. The whole was imported, and Germans sent twice as much to us as we received from the rest of the world. You know the familiar story of British sugar-refining under political economy as against what it might have been under national economy.

Less than a century ago Britain refined all that she used. Thirty years ago we still produced five-sixths from imported raw sugar with the added benefit of the by-products. Of late only one half was manufactured in Britain, the industry falling into few hands and the others being frozen out by the free blasts of competition through our open door. The foolish foreigners —according to the gospel taught in our schools of learning—made a present to this nation by placing bounties upon exports, though with the avowed object of displacing our industries so as to retain a huge balance of national profit to themselves. They secured the turnover, enlarging the fertility of their soil for other products, encouraging the manufacture of machinery, providing cheap food for animals from the offal, remunerating chemists and furthering chemical research—these and other gains all at the same time, and all for Germany.

Yet the British Empire is well able to produce the sugar it requires. Disaster fell upon sugar-growers in the Crown Colonies, and had not our Oversea Dominions adopted a policy absolutely antithetic to that of the Mother Country, extinction must have followed there also. Canada came to the rescue of the West Indies, whilst Australia fought out not only the question of local production, but also that of the employment of white labour.

Whilst coloured persons, whose manner of life and forms of expenditure under very low remuneration added nothing to national strength and progress, were only able to turn out 80,000 tons a year, our white British Australian citizens have approximated a yield of 250,000 tons. The industry maintains a school of chemists of pre-eminent ability, and, moreover, workers and farmers are all well paid. Say the duty is two-thirds of a penny per pound, there are against that the great advantages of subsidiary trades, of support to steamer services, of cheap molasses for stock, of spirits for industrial purposes, of support to technical education and to advanced agriculture. And the entire gross value is extracted from the soil. Is that not enough? Why, then, allude to military strength, to multiplication of the British race, to the triumph of the industrial example? To say nothing of the fact that when the supreme trial of war finally came—as we knew it must come—the Australian citizen gets for threepence what now costs the *laissez-faire* Englishman sixpence. And all along the retail price of sugar in Australia was moderate.

Need we enlarge? Is the lesson not obvious? I am assured by the highest authorities in Mincing Lane that—apart from very probable rise in labour cost everywhere—a price of about £12 per ton for raw sugar, f.o.b. in the country of production, can be reckoned upon in the British Empire. In the French and British Possessions there are sugar lands yet to be reclaimed, and sufficient labour available to supply all possible requirements of the Allies. As already alluded to, the offal from the industry, both from cane and beet, is highly valuable for meat production—that want, of all others, which is sure to be accentuated in the coming years.

True, the sweetening value of beet compared

with cane sugar is as 12 to 14, yet the advantages to be gained by Great Britain are so great that every effort should be made to foster the industry, and to do so protective duties, or an equivalent bounty, must be provided. Once the industrial principle be admitted—namely, that it is a duty of the whole people to see that the whole people shall be provided with opportunities to earn incomes adequate to civilised existence in decent comfort—then the governing powers will neglect no beneficent industry. They will add up the advantages to the nation, which are not always measurable in coin. The very expenditure, which is debited *in toto* by the political economist, is often of itself a cause of gain, deny it as he will. The mechanical instruction, the chemical practice and experiment, the example already mentioned and the industrial experience gained—applicable and often applied to other forms of production—are imponderabilia which the political economist omits from his estimates. There is one quality which we manufacturers, in common with all business men, value perhaps more highly than any other—perception. The possessor of it may be a lazy fellow, like the boy Potter, who invented the slide-valve, yet we are glad to buy or hire it. That is what each industrial development brings in its train—cultivated acuteness. To beet-sugar production and all else the same observations apply. You cannot instal a new industry without helping many others.

But contracts are now being offered in Mincing Lane for German sugar—so says "the trade"—for delivery when peace is declared. Are we going to allow business to the extent of £15,000,000 a year to leave the British Empire, as before the war, to strengthen quondam enemies? Yet powerful co-operative bodies are suggesting this, who are themselves large purchasers. As prices will be much higher, so the fifteen will swell to twenty millions sterling.

No Zollverein Possible.

Whether the country be large like Canada or Australia, populous as Great Britain, or smaller like New Zealand, the West Indies or the Falkland Islands, the ruling powers will make their own separate fiscal arrangements to a certainty. It is chimerical to suppose that there can be arranged a Customs Union—a Zollverein, as our Free Trade friends so love the German word. In twenty years it would be impossible to start such a convention, and its failure were inevitable. Free Preference is, however, not only assured, but it is a fact of existence. The Political Economists thundered at us who consistently fought the battle for sense and right—*sensus communis* in its highest meaning—that if we succeeded we should break up the Empire. Free imports alone, said they, would ward off war and win for our nation universal love and respect. We behold the result!

Britain followed out the folly to its bitter end. The eager affection of her Oversea sons counted for no more, fiscally, than the malevolence or indifference of aliens.

At the very time when Britain was being lulled to sleep and her prophets and wise men scorned, Australia was steadily exerting herself to do her bit in providing both army and navy. The aim was to have within a few years 800,000 trained men, even partially trained, at call. From which fact alone it should be plain that the Oversea nations of the Empire will and must make their own fiscal imposts and arrangements. The influence of Lord Haldane and his fellow thinkers could not be allowed to dominate the perceptions of Oversea electors. Compliance could not be enforced, and thus agreement alone can operate.

Allied Preference in Basic Material.

Schemes of Imperial cohesion, plans for inter-state and for Allied preference, usually embrace only dealings with manufactured goods. In connection with these, concessions are to be made in one form or other by way of rebates in import duties. The method is important, even requisite, and has the merit of simplicity *plus* experience in practice. But the very heart of the subject is elsewhere placed.

Sheep and Wool.

The supply of materials—constantly but wrongly called raw materials—is basic to all manufacturing industry. Monopolists know all about that, but serenely say nothing. They only ask for *laissez-faire*—desire nothing more than to be tenderly let alone. But it behoves the Allies to unwind the tentacles of these octopods and, if the unwinding be too troublesome, to cut them.

A combine controls the meat industry of the United States, has spread its control to Argentina, and is making vigorous attempts upon Australia and New Zealand. It encounters grave difficulties in Australasia, yet its immense success in dollar-raking over America and Europe suggests that the same procedure is practicable for wool and hides.

The colossal aggregations of capital seeking wide engagement, consequent upon the great war and accumulated in America, could find no more ready and profitable employment unless we be alert to prevent our own enslavement. British companies with pastoral holdings in Australia—often of great extent—may individually sell out to an American combine. Separately and seriatim, Australian persons and companies may do the same, and the purchase-money be withdrawn, as it mostly would be. That is not gain but loss to Australia. The ever-augmenting profits will be transmitted abroad, whilst wages and working expenses would be paid alike in either case.

The number of sheep in any country varies greatly with the seasons, but we may reckon as follows: The principal wool-exporting countries are Australia, owning 85,000,000 sheep; New Zealand, 25,000,000; Argentina, 85,000,000; and South Africa, 27,000,000. Of these the only one tending to an increase of its flocks is South Africa. There are 20,000,000 less sheep in Australia to-day than twenty-five years ago. In my calculations I have taken three-year periods so as to correct divergences because of seasonal effects or of interruptions in shipping. Thus for 1901 I take the average of 1900, 1901, and 1902, or for 1912, the average of 1911, 1912 and 1913, that our guidance may be safe. Thus we see that in 1900 the wool exports (not production) of Australia were 540 million lb. weight, and for 1912, 800 million lb., or an increase of 50 per cent. The industry is inherently healthy, but trammelled by illiberal conditions that we need not here discuss. The wool exports of South Africa in the same dozen years have enlarged from 76 million lb. weight to 176 millions—much more than double. In the newly-extended dominion of the South African Union there is fair prospect of wide expansion in the pastoral industry. The fact that private enterprise has improved the capacity of the sheep in wool-bearing has nothing to do with the falling-off in numbers. That is attributable to political mismanagement, which is a history to itself. Meantime the demand for wool is stronger than ever, and must for a long time remain unsupplied. There is no trust, no control, no concerted arrangement among the producers themselves to carry over from one season to the next or to withhold supplies when foreigners conspire against the producers' interests.

The whole United States possess barely 50,000,000 sheep, and Canada only 2,000,000—an inadequate total for more than one hundred million people.

The production of Great Britain has been stationary for a dozen years.

No further demonstration is needed of the necessity for preferential treatment of the exportable yield of the Empire in favour of ourselves and our Allies, particularly when we reflect that the deficit in production of the best of all clothing material enlarges annually. It must continue to enlarge until the political treatment of the waste lands of Australia becomes more just or more generous.

Horned Cattle.

In relation to cattle, I need not burden you with the statistics which are before me, for it suffices that similar conditions prevail. The world faces meat shortage and again an enlarging deficit. With that fact both Americans and Germans are perfectly acquainted. Again, in this respect—possession of horned cattle—the United Kingdom is stationary for a dozen years. Canada and New Zealand show a small increase.

British India—assuming that the published figures are reliable—shows an increase from 85 to 112 millions in cattle over a stretch of years.

Hides and Skins.

Now, a significant tendency has been for the United States and Germany to derive in ever-increasing quantities from Imperial flocks and herds another basic material of vast importance—skins and hides. There is no effective substitute for leather, and prices continue to advance.

Jute.

Of this India is sole producer. The production has increased as follows: in 1900, 2,000,000 acres, with 1,200,000 tons; in 1914, 3½ million acres, with 1,900,000 tons. Here is an article under complete control wherewith to assist ourselves and our Allies.

Once more permit me to remind you that the items and figures adduced are not comprehensive but illustrative, else you could not see the wood for the trees.

Cocoa.

Reckoned in short tons of 2,000 lb., the exports of the producing countries of the Empire have been so augmented as to show, in 1900,

shipments of 29,000 tons, and in 1912, 90,000 tons.

But of all products the most remarkable progress is shown in

RUBBER,

which from 9 million lb. weight in 1900, advanced with steady and rapid increase to 96 million lb. in 1913. There are £95,000,000 of British capital invested in the rubber-producing industry, and our share of the world's supply is 92 per cent.—say, eleven times as much as that of the rest of the nations added together.

LEATHER.

Not merely of hides, skins and leather itself, but of invaluable tanwares—cutch, myrabolans, wattle-bark, hemlock, chrome—our Empire produces for all the world. Without the control of hides and skins from India Germany will be in a bad way. Well-informed Indian officials have told me, "We were running India for the benefit of Germany."

Ministers in Australia have long ago seriously considered the question of imposing export duties upon hides, in order to conserve the tanning trade—the Cinderella of industries. Bark of the Australian acacia is an important product of South Africa, and though its cultivation in Australia has been neglected, it is perhaps, all round, the most valuable of the tanwares.

COCONUT OIL.

The absence of its manufacture from England is due to the wilful choice of Englishmen to erect factories in Germany so as to extract it there. Perhaps it is merely to exemplify the high principles of political economy so to sink their capital in a foreign State, employing labour there, filling German steamers with imports and exports, supplying excellent food for man and beast—to the deprivation of Britain—and the best material for detergents. Perhaps it was merely *ubi aurum, ibi patria*—policy of economy, and the devil take the hindmost. Many of us who travelled in Germany were amused by the queer jumble of words that stared at us from countless hoardings and from hideous newspapers—"Sunlight Seife." It is up to England to see that her own farmers get the benefit of the oil-cake, the by-product grown in her own Oversea domains, and that her Allies get a share in it too. And it will be no waste of time to watch keenly the pacifist influence of the whole soap-boiling trade. It had an octopus power of absorption, but Germany has stuck in its throat.

From the examples cited will be readily seen our power to benefit both Empire and Allies by ordered co-operation. Illustrations could be multiplied *ad libitum*, especially by including the whole range of metals and minerals excepting potash. The latter can also be found if systematically sought for.

THE WAR AS SCHOOLMASTER.

Fas est et ab hoste doceri. Before me are a number of copies of the *Kölnische Zeitung*, and it is not only a fair thing, but a very necessary thing, to be taught by our enemy. At least, it is wise to acquire knowledge of what he is teaching his own people. It is sure to come in handy later on, and the ostrich attitude will not help us at all. We dare not ignore the psychology of the Germans. The same man will be lachrymose one minute and savage the next. He will be querulous and critical, then obedient as a child to superior authority. He can be kindly and cruel, suspicious and credulous. Obsequious to servility, he will tell you stories of his multitudinous rulers and royalties, as also of their ancestors, that would put Suetonius and Macrobius to blushes. Such works as those of Clausewitz and Treitschke could not be written by a Frenchman. No Englishman could produce Krafft Ebing's awful "Psychopathia Sexualis." So, too, with the daily press. It is, of course, for Germans, and its leading matter is of late a long-drawn whine alternating with coarse boastfulness. I translate some extracts:—

"The war," says the *Cologne Gazette*, "burst upon us as the consequence of a deliberate policy, which is provable by documents, carefully devised for the encircling and suppressing of Germany, the undermining and destruction of Austria and the partition of Turkey. It was based upon the hope that the numerical superiority of the forces of the Entente, which had itself been reformed and enlarged, would find internal support and help from party oppositions in Germany, from national animosities in Austria-Hungary, and from weakness of Turkey, towards the subjugation of Germany and her allies. The declarations of our enemies prove that their war aim is permanently to weaken ourselves and our associates, so that we, in contrast with the aspirations of England, France and Russia towards a world-embracing policy and control, shall be condemned henceforth to the position of a State of secondary rank. We are to be forced into a condition of chronic anæmia in the domain of world-policy. The partition on the planet of dominions and spheres

of influence, together with the exploitation of the world's markets, is as far as possible to be completed without us. That they still, even now, hope to attain their goal, and that, if they gain the upper hand, they will carry out this programme restlessly and ruthlessly, our enemies leave us no room to doubt." The conclusion, drawn at too great length for full quotation, is that a peace must be forced through first of all, in which the pledges, the forfeits, that Germany has won from her foes, and will hold at her absolute disposal, shall procure such terms as will secure her position hereafter, for her war aims never included the idea of making conquests, as has been the invariable practice—so declares the veracious *Gazette*—of England. Another number contains an illuminating article upon :—

"England's Strongest Weapon—the Press."

"Its excellent cable service," says the *Kölnische Zeitung*, "in all parts of the world is a powerful weapon of the State, and ever since the outbreak of war has only too well proved itself as such. More even than the technical does the intellectual rule in its handiwork, guided by unswerving power of will and by long experience. In the leading articles of the English daily press during the war a great art is manifested in dealing with the separate nations according to their idiosyncrasies (*die einzelnen Völker nach ihrer Eigenart zu behandeln*), at one moment to strike the chords with severity, the next with brutality, then again with flattery, just as they hope to win success. Others again must be won by surprise-attack or by simulated probity." Then follows a column of abuse more amusing than instructive.

International Fairs.

But the same paper affords us a valuable finger-post in its report of Dr. Stresemann's speech in the Reichstag upon the question of the Leipzig Fair. Deputy Carstens had said :—

"The importance of the Leipzig Fair for our trade, our industry, and our workpeople is proverbial. Every possible effort must be directed towards maintaining the Leipzig Fair in its present importance. Germany, her trade and industry, her technical schools and her science, will constantly take care that the Leipzig Fair shall never be conquered. In view of the exertions of our enemies to continue a trade war even after the war, we must place all means in the hands of the Government, so that it may oppose successfully all assaults upon German industrial life."

Agreeing with the foregoing, Stresemann said, *inter alia* :—

"I am of the opinion that the proposal for State assistance to the Leipzig Fair is the obvious reply to the efforts of our antagonists to continue an economic war against Germany after the war. And just here in the Leipzig Fair we have the possibility of giving an answer to them. Even during the present war France, as well as England, has attempted to break through the old world-monopoly (*das alte Weltmonopol*) which the Leipzig Fair has won for itself through its conspicuous accomplishments in connection with the quality of German goods. England, which was formerly not only the land of Free Trade, but also in so far the land of free competition, as it almost never placed any State means at disposal for the support of industrial efforts (*wirthschaftlichen Bestrebungen*) has now, according to the information received, voted no less than £700,000 to create in Liverpool a counterpoise to the Leipzig Fair. France has applied herself to creating in Paris a fair for tobacco goods, for toys, and for furs. Under the leadership of the very active Mayor of Lyons, Monsieur Henriot, the attempt has also been made to call into existence a great fair as a counterpoise to Leipzig."

Deputy Schiele, of the Conservative party, said :—

"The Leipzig Fair is a concern for the whole nation. We shall not recover after the war even economically the *status quo ante*. Therefore everything must be done to reconquer the foreign market in behoof of our working-class. The late Ludwig Frank said that if we do not win the war, both in the military and the economic field, we must export men instead of merchandise. This Leipzig proposal is merely the introduction for other endeavours in furtherance of German export trade."

Dr. Bell, of Essen, said :—

"Even during the war everything must be done in the interests of our export trade. If after the conclusion of peace our enemies want to continue the trade war, we must stand up industrially armed. The watchword must be, 'Hereafter, as before, let the Leipzig Fair lead the world!'"

Allied Exhibitions.

At the risk of wearying you, it seemed well to point again to the wisdom of holding international fairs in the countries of the Allies, in other words, exhibitions which shall be professedly glorified shops, where only goods may be shown for sale purposes directly or indirectly. On that basis the whole public will

be interested, and every fair should be a financial success towards further and finer displays. And the exhibits should be limited to the Allies, so as effectually to assist in recuperating our injured fortunes. Even if the American eagle should scream, for once never mind him, but do all that is fair and lawful to help ourselves and help our friends. If we do not follow out such a policy, the glorious Alliance will fall apart—as the Germans confidently prophesy—and new associations of the Powers will be formed, to this Empire's imminent peril. This is not the last of wars; men will still be men; evil will persist in the world; avarice and luxury will again bring chastisement upon nations; peace, wealth and ease will form no guaranty for love, honour and purity. Our worst foes will be those of our household who will talk disarmament and dazzle our eyes with the films of Utopia.

Professor Muth, of Munich, whose name in German signifies "courage," published, in an intellectual serial, *Die Süddeutschen Monatshefte*, the text of a remarkable paper by Vincento Ludoslavski, a Polish writer, in which he declared that the British Empire has hitherto carried out and is still fulfilling a glorious mission in the earth. "Because," he said, "it was not built up by man, but is the handiwork of God—it can never be destroyed by man." There, then, is our trust as set forth, not by our own lips, but by another's, and as fiduciaries and without predilections it is for us to maintain the august heritage. It is not ours for ease and sport and pleasure alone, but to be carried on with regard to our awful responsibility. Then, indeed, will it be secure and, not without imperfections, remain the most beneficent creation of human genius.

"Economic Life after the War"
("*Das Wirthschaftsleben nach dem Kriege*").

I translate from the *Frankfürter Zeitung* of last month part of a private telegram which gives extracts from a speech of the Director of the German Grain-purchasing Department, Under-Secretary of State Michaelis. It was given in the Berlin University and was upon the "Providing of Bread-grain for the German People." After speaking hopefully of the present outlook for supplies, counting upon Rumania, he dealt with future prospects.

He distinguished the period of transition after conclusion of peace from the further future. This, let me remind you, is from a proved and able business man. In close translation the article runs:—

"For the transition period, which Michaelis reckoned to last for several years, he declared it to be indispensable that the Imperial Grain Office, as also the commandeering and rationing, must remain. It would be a wrong idea that with the declaration of peace the food-troubles would be at an end, and that across the wide-opened frontiers all would pour in that we are now lacking. The adjoining countries, as well the enemy as the neutral, find things as bad as we do, and they also will be just as slow to recover. Even America now threatens export prohibitions. Our agriculture has become poorer through want of nitrogen. We must therefore reckon, says Michaelis, that we must manage for years to come with our own production. Relief will begin firstly with the reduced demands for the army and from the conquered domains, which will be at our disposition for the provisioning of Germany with grain. But such improvement will only enter gradually, and it is wrong to clamour 'Give us peace, give us bread!' By the conclusion of peace the food-troubles will not be immediately lessened.

"Whether in the further future"—the Minister continues—"by utilising our experiences in the years of war and of transition, the control of home-grown grain or of that imported from abroad shall be taken over and dealt with by the State, is still an open question. But people must accustom themselves to the thought that after concluded peace the expenses of the German Empire will be quadrupled, if not indeed multiplied five-fold. Under the enormous pressure which the deterioration of our public economy, and at the same time of our individual husbandry has evoked, we shall be necessitated, for the restoration of ordered industrial life, to accustom ourselves to ideas which without this need and stress we should wholly reject. In this sense the war will prove, especially after its close, to be a stern schoolmaster."

Equally striking revelation of the radically hopeless position of the Germanic Empires is made in the Reichstag debates upon the food supplies, but to a commercial man like myself the most illuminating glimpses are obtained in the market and company reports. The subject is far too wide to enter upon, though intimately related to industry after the war. The deduction for us is to support in all conceivable ways our nation and Government in their efforts to raise promptly to a maximum the concentration

of energy. Above all things, to assist and insist upon tightening of the blockade. To weaken the enemy is nothing else or less than to win battles. To that end, therefore, squash our own *soi-disant* pacifists by any and every means, for out of their malevolent activities, were they successful, would assuredly come a renewal of the bloody conflict in still more awful form. As before said, we shall either end or extend the trouble.

Enemy Clothing.

Instantly, when war broke out, Australasia forbade export of wool and meat. Worse than lack of food is lack of clothing, for the former is remediable, but the latter is, in the military aspect, hopeless deprivation. All possible alertness could not save the enemy. He thought to find other fibres, and made experiments with nettles. I find from his own papers that the whole stock derivable, after concentrated scientific effort, and employing, according to the *Frankfurter Zeitung* of December 5th, 12,000 people in all parts of the Empire, amounts to 1,650 tons of dried nettle-stalks up to that date. Say with a yield of one-fourth actual fibre, the result is about 400 tons. Obviously an amateurish and unpractical scheme. The fibre is useful in peace time, but for uniforms inapplicable, because it will not stand strain and exposure. Repeatedly I find allusion to the spinning of artificial silk—a celluloid preparation —and of paper, no doubt a form of Kraftpapier; both useful enough ordinarily, but again inapplicable for military purposes.

To placate America in the traditional way, indirect deliveries of cotton to our enemy were permitted by us upon a vast scale after the start of hostilities. The effect was to raise his strength and hope, as also to raise immensely the cost of cotton to the Allies. After the war the Allies, in continued alliance, will be big enough and strong enough to take independent action commercially in their own behoof, and to consider their common interests in preference to those of dollar-chasing neutrals.

Foreign Domination.

America controls five-sixths of the entire tobacco selling trade of the British Empire. A single man, resident in Long Island, New York, possesses nineteen-twentieths of the sewing-machine manufacturing and selling of this Empire, owning not less than 60,000 branch establishments throughout the world. That is the apotheosis of capitalism and *laissez-faire*; but it is not in or for our interests. Is it even necessary to say so? Yes, and to say it a thousand times until attention be paid to it. For there is now in practice and further preparation by Chicago monopolists a comprehensive scheme to obtain monopoly of meat production and sale within the Empire *per fas et nefas*. Your neck is in the noose now, and your hopes are far more with the action of the Dominion parliaments than with the unwieldy British legislature hampered and hide-bound with scholastic tradition.

A Parliament of 670 members means an attempt to govern by public meeting. Dealing with the tangled controversy of Ireland has been its chief occupation, as well as the basis for the choice of its members, so long as I can recollect. Yet Ireland has fewer inhabitants than Australia or Canada, and not a tithe of the importance of either.

Arguments favouring the creation of a Parliament of the Empire have been often and amply refuted. The rejection of the necessary referenda by any of the States would be too disconcerting an outcome to justify the risk. History indicates other, sounder, and safer expedients.

It is a sure thing that our Allies will gladly help in keeping the respective domains of the several States—those of the ten Allies—from foreign domination and undesired exploitation. Or, on the other hand—limiting ourselves to the British Empire—if the Imperial Parliament would sweep away and keep away the foreign octopus of monopoly, whilst Canadians and Australasians were handed over Sinn Fein to deal with in its next outbreak, there would be "something doing." That is but a beautiful dream.

Cable and Aerial Messages.

Recalling the German tribute to our superb system of world-cables, why should we not offer freely to our fighting friends a preference in its use? What about grappling them to our soul with hooks of steel, or are we to drop them where they are, merely to placate the neutrals that did nothing for us anyway, unless it be a favour to sell us commonplace stuff at outrageous prices? It would greatly help our interstate commerce and Imperial progress if there were duplication and expansion of the services, so as to carry messages at low and unremunerative rates. Profit and increased interchange would follow.

Monopolies of Invention.

That channel through which aggregated foreign capital can and does exert an overwhelming force, in exploitation of mankind's energies, is popularly called "patents." The familiar word has been so distorted from its proper use as to be almost exclusively applied to authorised monopolies. The Associated Chambers of Manufacture of Australia specifically and spontaneously appointed me as their spokesman in London, and upon their behalf I am entitled to say that this subject of monopolies has not only caused them great concern, but has been the cause of repeated representations to the Commonwealth Government. The industries of the Empire suffer severely all the time from restrictions and imposts by foreign monopolists. Purchased often from British and Colonial inventors at low prices or insignificant royalties, the people of this Empire are bled secretly but surely to an incredible extent, and disadvantaged in many ways, by these monopolies.

Chiefly by litigation at enormous cost, thus terrifying recalcitrants, American holders of monopolies in shoe-making machinery particularly, renewing and extending their control by extremely clever manipulation, extract really royal revenues from the British Empire. This is unknown to all but those users who primarily pay the exactions.

The whole incandescent light industry was held in duress by an Austrian monopolist, who, by daringly vague but therefore comprehensive patents of monopoly, derived power for further exploitation. To fight his claims to monopoly of the use of a range of natural agents was proved to be ruinous. He lavished money upon the costliest legal advice and litigation, winning all along the line. The British public does not want monopolies, but its lawyers do. When the subject of these patents of monopoly comes up, in the course of years, before the Council of Dominions of the Empire, there will be a hope of remedy. Probably not till then.

The German Octopus.

After Armageddon you will have to deal with an industry in which the European nations have hitherto been most diligent, and for whose termination the soul of mankind prays with an inexpressible longing. That is the practice of setting up German kings, kinglets and princes to rule over the lives, liberties, and hopes of harmless nations. In that business we British have assumed a ghastly pre-eminence, and truly the Hohenzollerns owed us an everlasting gratitude. Let anyone take the "Almanach de Gotha," issued by Julius Perthes of Gotha; the German publication selected by our authorities and censors for untrammelled circulation in our midst. Let him take that mine of information and dissect it upon a pack of ledger-cards, firstly setting aside all prepossessions. Let him study and compare as I have done, and he will learn what the alleged "*Dei gratia*"—the "Grace of God"—has done for him and for hapless mankind. Let him plot out on the map of Europe the details of German interpenetration, and ask himself—himself alone—if he would assist in spreading the industry to France?

In 1870, the ostensible cause of the Franco-German War was the resolve of Prussia to place a prince of Hohenzollern to rule over Spain as first War-Lord. The announced desire of our own rulers was "to see a strong Prussia," and they realised it, although poor, broken, humiliated France saved us from the Spanish danger. Does anyone believe that a real democracy—as the United States, Britain, or France—could design and carry out preparations for world hegemony? Would anyone of those peoples submit to an order from above, "You mind your shops and factories, and leave the war business to us"? We are paying in blood and tears for our distrust of humanity in permitting—and even forcing—other nations to submit to the imposition of German princes, and thus virtually instituting in potency a restoration of the Holy Roman Empire that was neither holy nor Roman. The mild rule of the real Cæsars, however unworthy some of the successors of the great Augustus, was founded on the principle of allowing democracies to govern themselves, and it brought a peace to the world over greater area and longer duration than it ever knew before or has ever known since.

Knowledge Wanted.

The same Julius Perthes of Gotha is publishing by authority a series of books setting forth the ways and means whereby Germany is to regain her position of trade control and manufacturing dominance when peace shall come. To this, as so often herein insisted, the *conditio sine quâ non* must be German control of materials, especially within the British Empire. I have anxiously tried to get those books, but am told that the Censor has issued orders that no such books may be procured from Germany. Not too many of us who are versed in manufacture

and production—as well as representatives of producers' organisations—are also conversant with the German language, German mercantile practice, and exchange. The British Board of Trade—I am able to say authoritatively upon behalf of Australian manufacturers at the least —does not begin to fill the gap. We greatly prefer unfiltered knowledge gathered by ourselves, for what the Board of Trade offers us we seldom want, and what we want we seldom or never get. Consequently, we rely upon ourselves and our organisations to acquire the needful guidance. Hitherto we have found self-reliance count for a good deal, whilst there is an increasing generosity in the interchange, amongst producers, of specialised knowledge.

We shall have to compete with the German, and badly want to know what cards he holds, inasmuch as he assuredly—through his Censor—blocks nothing at all that can guide him.

A Request from Australia.

In 1914 a request was sent to the British Board of Trade from the Associated Chambers of Manufacture of Australia, desiring that effort should be encouraged to form an Association in Britain specifically to represent the whole body of British home manufacturers. It was hoped that it might take the same place in the United Kingdom as the National Manufacturers' Association of Canada in the latter country, or as a similar body in the United States. An answer was returned that the Board did not consider such a movement would serve any useful purpose.

It was, of course, a severe rebuff, and as certainly undeserved, for the sole aim was conservation of British energy by mutual help in the furtherance of industry. It has always been felt by industrials in Australia that their activities were looked upon askance by one of the great political parties of England. The manufacturers of Australia employ 350,000 people, and produce in the year goods to the value of £166,000,000. Even the added value to the materials exceeds the total value of any other department of production. And to tell these citizens, possessed of boundless goodwill, that their proposal of friendly association with their colleagues in Britain would serve no good purpose demands an adjective which I leave to others to supply. The mistake, however, was in applying to the Board of Trade at all. National movements are best promoted outside of officialdom, and so good progress in the desired direction has already been made.

I have not adduced in detail illustrations of Allied interchange and preference in the basic domain of metals, for the reason that I have undertaken to do so at some length next week in another place. It suffices that we possess a power of control to an extent that should fulfil all desires.

To sum up. The British Empire possesses sources supplying manufacturing materials of which some are of basic importance and at the same time unique. Our foremost duty is so to continue to ally ourselves with our Allies in this life-struggle as to help them faithfully and materially in the long and arduous process of recovery and restoration. We can best do so by preferring them in the supply of materials of all kinds. It is an unproved assumption that our enemies will pay us better prices than our friends. Again, we shall secure for the latter, as for ourselves, outlets for manufactures. And all that, even if in so doing we refuse again to permit Germany to monopolise or share in control of Australian lead, zinc and copper, or to absorb so much as she formerly did of the small remaining deposits of English china-clay; or to purchase again English coal-mines.

Means of Control.

The whole commerce of a country is compelled to pass through one valve—the Customs. Whether exports or imports, free or dutiable, everything is thus subjected to registration and control.

By operating this valve—which is by no means solely for ensuring collection of duties—foreign frauds and deceptions upon the citizens are prevented, objectionable goods are excluded, and preference is given to the Mother and sister countries. So, too, in many British States, export duties are received, control exercised over the issue of their own products, and all requisite statistics obtained. It becomes merely a question for solution by the wisdom of each Parliament how far to extend the principle of present action. We have already the way, we need only the will.

To conclude. The only security for existence, with freedom of the smaller nations, is that the Grand Alliance shall continue. You cannot trust merely to a "scrap of paper." To prevent outrages that are remediable only by a deluge of blood, there must be an irresistible confraternity of nations. America is a chaos of unassimilated peoples whose future no one can forecast. It is neither a race nor a nation, blink the fact as we may.

Europe's liberties are in her own keeping. The security for them is by genuine brotherly preference in every thinkable way, beginning with national business alliances based upon this voluntary preference as distinguished from bargains of any kind. Trust the people, trust the peoples, all the time. You have to depend upon their sense of honour in the last resort. Put not your faith in German princes, but insist upon their eradication as the *fons et origo mali.* From the limits of the habitable globe it is the man of the people, of ten nations and of countless races, who rushed to the bloody crusade for Christ and Right:—

"You took the Cross, although you didn't show it,
'Twas graven on a heart and not a shield;
'Twas for the Cross, although you didn't know it,
You mocked the horrors of the blood-stained field.

"You were but one, there was a host of others
Who felt full manhood when the trumpets blew;
Unconsciously you felt they were your brothers,
Nor knew that God was calling them and you.

"I mean you didn't hear the voices calling,
You simply followed where the Spirit led,
And when you saw them all around you falling,
You didn't know it was for Christ they bled.

"Duty impelled you and you never faltered—
There was no need for her to whisper twice;
The end you saw not—no, nor would have altered:
You took the Cross and made the sacrifice!"

DISCUSSION.

Mr. C. Sandbach Parker, member of the West India Committee and Chairman of the British Empire Producers Organisation, said that those who sat with the author on the executive committee of the British Producers Organisation had the privilege of knowing better than some of those present did before, his views on many of the questions that had been raised in the paper. He thought it would be agreed that the paper had shed a searching light on the manner in which these matters should be treated in the future; certainly they had hitherto not been treated as they ought to have been in many places, including one place not far away. The British Empire Producers Organisation, which had been referred to in the paper, was endeavouring to organise the industries of the Empire with a view to carrying out the objects to which attention had been drawn, and if they could, without Government interference and with Government help, succeed in bringing about a change of feeling in this country, and a closer relation in the future organisation of trade between Great Britain and first of all with our great Dominions and Colonies, and next with our Allies, a work would have been accomplished which would leave its mark on generations to come. Mr. Beale had mentioned some of the many articles that were under German control before the war, and he (the speaker) had had experience with regard to one of them, sugar. It was in 1884 when they in the West Indies were being utterly ruined by the policy of this country, because they were absolutely prevented from coming to an agreement with the United States who desired West Indian sugar for their people, on the ground that it interfered with that well-known fetish, the most favoured nation clause. Not only were they turned out of their own country, but they were prevented from making arrangements with another country who wanted their sugar. There were scores of other cases in which the same policy had been adopted, and the German control of metals was an outstanding example. We had had our eyes opened since the war started, because even those who thought they knew the extent of the German control had not the least idea of the extent to which it had penetrated, not only in the region of industry but in the region of finance. The lesson of the war was that those of us who were not able to fight at the front for our country ought at home to see that the reward of the efforts of those who did was not lost. We must put our industry in such a state that after the war it would be possible to benefit the children and the grandchildren of those brave men who had laid down their lives for us.

Colonel C. E. Yate, C.S.I., C.M.G., M.P., said that although neither a producer nor a manufacturer, he had listened with joy as an ardent advocate of Imperial preference, to the paper. Mr. Beale had been appointed specially by the Australian Associated Chambers of Manufacture as their spokesman in this country, and they would all agree that Australia had made an excellent choice. The fact that the Australian people were now getting for 3*d.* sugar which costs 6*d.* in England was a justification of the policy which Mr. Beale advocated. If we had only had a protective duty years ago to foster the sugar-beet industry we should not have been in the position in which we were now. A new policy, he was glad to say, had recently been instituted, by which the Colonial Secretary had been empowered to put a tax on exports to foreign countries of palm kernels which were a monopoly in West Africa, and he hoped that jute and other monopolies in the British Empire would be treated in the same way. If anyone wished to know more about jute they should read the paper read last session before the Indian Section of the Society. As an old Indian officer he thoroughly endorsed what Mr. Beale had said about the German control of hides and

skins from India, and he fully appreciated the remarks made by the well-informed Indian officials, "We were running India for the benefit of Germany." He also appreciated the remarks in the paper about the Board of Trade, to the effect that "What the Board of Trade offers us we seldom want, and what we want we seldom or never get." He had seen the answer in connection with the request from the Associated Chambers of Manufacture of Australia regarding the formation of an association in Britain, viz. that "the Board did not consider such a movement would serve any useful purpose," given many times in connection with other matters, and realised the utter hopelessness of such a point of view. He hoped the policy recommended by Mr. Beale would come to early fruition as the result of the war.

MR. C. R. ENOCH remarked that the point to be borne in mind in connection with Imperial industries after the war was how to develop the enormous resources of the Empire so that they would be of benefit to the bulk of the people. Whilst we must trust the people we must also feed the people. Could it be done by State organisation, and should we in that way get more sugar, cocoa, fats, oils and other commodities from our Colonies, and he would specially mention the Crown and tropical colonies, or would private organisation be the best means? He believed that Imperial preference would accomplish a great deal, but we should have to go still further and see how we could get into closer touch with the enormous properties of the British Empire.

THE CHAIRMAN (the Rt. Hon. Sir Joseph Ward, Bt., K.C.M.G.), in moving a vote of thanks to the author of the paper, mentioned that he had received a letter of regret at his inability to be present from Sir Cornthwaite Rason, who also expressed his deep sympathy with Mr. Long in his terrible loss. With regard to the paper it was obvious that it could only have come from a very fruitful brain. Mr. Beale was diffusing the great feelings of dissatisfaction felt by the great proportion of the people in the Overseas Dominions—and to a large extent now by people in this country—with the pre-war conditions under which our enemy was making tremendous advances all over the Empire. In New Zealand preliminary steps had been taken to bring about a change, and he himself had put a clause into a Bill last session—it was now an Act of Parliament—under which, the moment peace was declared, an extra 50 per cent. duty would be placed automatically on all imports from an enemy country.

The vote of thanks was put to the meeting and carried unanimously.

MR. BEALE, in reply, said the only point that called for immediate comment by him was the remark of Mr. Enoch as to how we should develop the great resources of the Empire for the benefit of the whole of the people. There could not be a better man to answer that question than Sir Joseph Ward himself, because when he was in New Zealand he taught us from observation, imitation, and experiment how to make the most of the Empire's resources. If there were awkward experiments they had the courage in New Zealand to try them, and what was more they made them successful. If that example were copied throughout the Empire the whole object he had tried to explain would be attained. One instance of the good example set by New Zealand was when Sir Joseph Ward was Treasurer out there at the time differential duties were imposed which were to give a preference to Great Britain. As a mercantile man observing such matters, he was entitled to say that it was done with really remarkable skill. For instance, cement was an article heavily exported from Germany, it being used to give "stiffening" to German vessels trading with Australasia. The general range of duties was 50 per cent. higher against foreign competitors, but they put a double duty on cement, and he could safely say it was meant to hit German cement. At the other end of the world, at all events, they always looked on Germany as their potential enemy, and neither Mr. Enoch nor anybody else could have any idea of the consternation and even anger in the Overseas Dominions when Germany was granted a slice of New Guinea to enable her to set up a naval establishment and threaten, if not dominate, the southern seas.

MR. G. WILSON, C.B., on behalf of the Committee of the Colonial Section, thanked Sir Joseph Ward for taking the chair.

TENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 14th, 1917; The RIGHT HON. LORD FARRER in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Bertrand, J. F., Isle Verte, Temiscouata County, Quebec, Canada.

Chrimes, Thomas Edward, R.N.A.S., Holmcroft, Wilbury Villas, Hove, Sussex.

Comber, Joseph Forstall, Assoc.Inst.C.E., The Lagunas Syndicate, Ltd., Oficina North Lagunas, Iquique, Chile.

Eckford, Captain George, R.E., The Old House, Milston, Salisbury.

Lewis, Nolan D. C., M.D., Crownsville State Hospital, Crownsville, Maryland, U.S.A.

Loring, Mrs. William Caleb, 2, Gloucester-street (corner of Beacon-street), Boston, Massachusetts, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Chellew, George, 99, Chevening-road, Willesden, N.W.

Davis, William Alfred, Pusa, Bihar, India.

Rodd, Captain William James Paulo, A.O.D., c/o Sir Charles R. McGrigor, Bt., and Co., 39, Panton-street, Haymarket, S.W.

Stone, Judge Kimbrough, Kansas City, Mo., U.S.A.

THE CHAIRMAN, in opening the meeting, read the following letter from Lord Eversley, the veteran Chairman of the Commons and Footpaths Preservation Society:—"I very much regret that I am unable in this inclement weather and at my age to go to London for the purpose of being present at the meeting of the Society of Arts, when Mr. Lawrence Chubb will read his paper on "Highways and Byways." I have not read his paper; but I feel very certain that I shall agree with all he says on the subject, for no one knows better than he does the difficulties which arise when the public desires to assert its rights." He had also received a letter of apology for inability to attend the meeting from Lord Weardale. Everyone was interested nowadays in the subject of highways. He knew it was said that *inter arma silent leges*, but still they had had such experience lately of the importance of means of communication that the history of them ought to be exceedingly interesting. Now that railway travelling had to be given up from patriotic motives, more use would be made of highways and footpaths, and to keep the footpaths open appeared to him to be one of the primary conditions of the happy civilisation under which English people had lived for so many years.

The paper read was—

HIGHWAYS AND BYWAYS.

By LAWRENCE W. CHUBB,
Secretary to the Commons and Footpaths Preservation Society.

The story of the King's highway has the rare merit of being able to arouse the interest and quicken the imagination of all sections of the community. It appeals to the historian and to the student of sociology, because each great era of road construction or improvement in this country has synchronised with vital changes in the social life and environment of the people and in the economic development of the land. It was, for instance, due to the vast network of roads constructed during the period of Roman occupation that Britain was finally subjugated and the door was opened to the forces of civilisation as well as to the effective use of military power. Again, the coming of the Turnpike Trusts and "Macadam the Magician" contributed largely to the enormous expansion in industry and commerce which took place in the Georgian period. It will be the task of the future historian to appraise the services rendered by highways in these days when the fate of nations is in the melting-pot. In the meantime, none will deny that problems of vital importance in connection with the rapid transit of troops and supplies have only been rendered possible of solution by practical experience gained on highways in connection with the development of the motor-car.

The romantic and picturesque incidents associated with ancient and modern methods of travelling have, since the time of Chaucer, exercised a striking influence upon literature, and the subject of highways has, for mundane and other reasons, a great attraction for the lawyer and engineer. It makes its strongest appeal, however, to the imagination of the man in the street, for the word "highway" symbolises public rights and freedom—

"Fair and free, night and day,
Fair and free is the King's highway."

It is to this aspect of the subject that I desire mainly to draw attention because, while every individual is personally concerned in the preservation of highways, few realise the limitations of public rights and the difficulty of maintaining them, or appreciate the ceaseless and bitter struggle which the Commons and Footpaths Preservation Society has found it necessary to wage on their behalf in order that those rights may be maintained.

A public highway may be defined as a strip of land over which every subject of the King is lawfully entitled to pass. The extent of his rights is another matter. If he is merely entitled to passage on foot, the way is a highway for foot-passengers only; if he is entitled to ride a horse over a track, the way is a bridle-path or horseway, and a footpath as well. If carriages may lawfully be driven by the public over the way, it is a carriage road and also a bridle-path and footpath.

The public right is confined to an easement of passage; it does not embrace the ownership of the soil, which, in most instances, remains vested in the adjoining owner or owners by whom, in normal cases, is owned the freehold to the centre of the metalled portion of the carriage-way. That is why the timber growing on the open wastes at the sides of roads belongs to the adjoining owners. So jealously do the Courts preserve the landowner's interests that it has been held that a man is not entitled to walk

backwards and forwards along a public path over a Yorkshire moor in such a way as to interfere with a grouse drive (*Harrison* v. *Duke of Rutland* (1893), 1 Q.B. 142). In delivering judgment in this case, Lord Justice Lopes enunciated the legal principle involved. He said: "If a person uses the soil of the highway for any purposes other than that in respect of which the dedication was made and the easement acquired, he is a trespasser. The easement acquired by the public is a right to pass and repass at their pleasure for the purpose of legitimate travel, and the use of the soil for any other purpose, whether lawful or unlawful, is an infringement of the rights of the owner of the soil, who has, subject to this easement, precisely the same estate in the soil as he had previously to any easement being acquired by the public." In another case (*Hickman* v. *Maisey* (1900), 1 Q.B. 752) the defendant was held to be a trespasser because he walked backwards and forwards along a public carriage road in order to observe the form of horses under training on adjacent downland. In this case, however, Lord Justice Smith held out a crumb of comfort to the weary wayfarer, for he said: "If a man while using a highway for passage sat down for a time to rest himself by the side of the road, to call that a trespass would be unreasonable. Similarly, if a man took a sketch from the highway I should say that no reasonable person would treat that as an act of trespass." In another dispute (*Fielden* v. *Cox* (1906), 22 T.L.R. 411) the Court declined to grant an injunction to restrain persons from trespassing on a highway by using it for the purpose of catching moths by means of lamps and other appliances, on the ground that the trespasses were merely technical.

Nevertheless, the strict legal view is that a pedestrian is not entitled to a general right to stray over land not dedicated to the public use and enjoyment, although that land is unenclosed common or open down; and so accustomed are we to speak with pride of an Englishman's rights that it comes almost as a shock when we first realise that his most comprehensive right—a right of way—is confined within exceedingly narrow limits, and that it is possible that a man may be a trespasser upon a public highway.

Having thus considered the nature of a public highway, it becomes necessary to make some inquiry into the origin and history of such ways. Theoretically, every highway must have originated either by the operation of an Act of Parliament or by dedication—express or presumed—by some owner of the land over which it passes. Although, as we shall see, a number of carriage roads and fewer footpaths have been created by statutory authority, the vast majority are deemed to have come into existence by means of dedication. "Dedication" is the expression used to describe a convenient legal fiction devised to account for the existence of a public interest in highways. The word connotes the grant to the public, by some past or present freeholder, of a perpetual right of passage over his land. On rare occasions dedication may be proved by the production of an actual grant, or it may be implied by special acts clearly indicating the intention of the owner to give to the public an inalienable right of passage. This form of dedication is known as "express" dedication, but it is not often possible to establish it. All that can be proved in normal cases is that, throughout living memory, a path or road has been publicly used as a thoroughfare, freely, openly, and without interruption. Where this is possible it is presumed that dedication has taken place, although no actual grant can be produced.

It is obvious that the percentage of rights of way which have been dedicated in a literal sense must be infinitesimal, for few owners would be inclined voluntarily to burden their property with an easement which, once existing, could only be lawfully extinguished by Act of Parliament, or by an elaborate and expensive process involving a justices' certificate and the consent of Quarter Sessions, or by the utter destruction of the way through some act of God.

When it is remembered that the antiquity of highways in general cannot be gainsaid, the doctrine of presumed dedication, and all that it involves, appears to the lay mind to be not far removed from the ridiculous. Some deeply-scored by-roads in use to-day probably existed as foot-paths and pack-ways in the time of the early Britons for the conveyance of tin and furs in pre-Roman days. Yet each of them is deemed to have originated in dedication.

Before asking you to consider the difficulties which the public encounter in maintaining their rights of way in consequence of the far-reaching effect of the theory of dedication and all that it implies, it may be convenient that I should outline the origin and development of our highway system, and the manner in which ways have been created by Act of Parliament. We owe the foundation of that system to the

Romans. Those wonderful road-makers were worried by no problems with regard to dedication or the sacred rights of property, but drove their ways over hill and dale, through morasses and dense woodlands, with a relentless purpose and patient industry which we can only admire with amazement.

The main Roman roads certainly extended for an aggregate distance of 2,500 miles, and some scholars of repute believe that their total length in Britain amounted, with their connections, to over 4,500 miles. When it is remembered that the flint, gravel, and other material required for the high causeways on which the roads were formed sometimes had to be carried for great distances, it is possible to realise something of the marvellous achievement of the Romans.

The construction of important trunk roads must have led to the opening of many cross tracks, but there is no evidence of efforts to maintain any of the Roman roads after the departure of the legions. They endured in spite of neglect, because they were well built. Indeed, the four great routes, Watling Street, the Icknield Way, the Foss Way and Ermin Street, came to be regarded as of value for a reason quite unconnected with traffic. They gave the King's peace or sanctuary to any man who fled to them for succour. While on them he was safe from pursuit or molestation.

With the imposition of the rule of the Norman and the organisation of the manor as a unit of local government, the maintenance of the King's highway was imposed as a theoretical duty upon the lord of the manor and his tenants subject to the adjustment and control of the Court Leet. Wheeled traffic was almost unknown, save for the rough carts utilised to carry home the crops, and the customary highways were for centuries almost exclusively traversed by pedestrians and horsemen. Until the dawn of the nineteenth century the principal part of the corn in remote districts was conveyed to market by pack-horses, although in some places common carriers were prepared even in the fourteenth century to convey grain by cart at the rate of one penny per ton per mile.

The Statute of Winchester, passed in 1285, was the first Act of Parliament which purported to deal with roads. It did not go far, for it merely ordered that "highways leading from one market town to another shall be enlarged where as bushes, woods, or dykes be, so that there be neither dyke nor bush whereby a man may lurk to do hurt within 200 ft. of the one side and 200 ft. of the other side of the way." No attempt at actual maintenance of the surface of the highway was made, or was considered necessary, until the growth of vehicular traffic rendered repair an imperative necessity. If the way became foundrous or impassable, the traveller might deviate upon the adjoining land, even if cultivated, for the judges decided that it was "the good passage" that constituted the highway and not merely "the beaten track." Where the land on either side of a public way remains unenclosed this rule still obtains, and if fences are erected to separate the highway from the adjoining land the burden of repair, *primâ facie*, still falls on the adjoining occupier, as long as his fences debar the public from their common law right of deviation.

It was not until 1555 that another Highways Act was passed (The Mending of Highways Act, 2 & 3 Philip & Mary, cap. 8), and this once and for all cast upon the inhabitants the obligation to maintain the highways in their parish. Surveyors of highways were ordered to be appointed by the parishioners, and were authorised and required to direct the performance of statute labour upon the roads. This was a form of National Service which no man might lawfully evade, but which imposed a burden from which all endeavoured to screen themselves. Nevertheless, roads became more neglected than ever, and were monopolised by large droves of cattle, sheep and pigs; even flocks of geese slowly tramped their way along the muddy ways from Norfolk to the markets of London. Many new highways, too, came into existence with the passage of thousands of Acts authorising the inclosure of commons. The awards made in pursuance of the Acts directed the setting out of convenient ways, but the question of repair remained unsolved. Turnpike trusts were therefore devised to remedy the deplorable state of neglect into which the King's highway had fallen. Certain individuals, with a view to the repair of particular roads, subscribed among themselves for that purpose, and erected gates upon the roads, taking tolls from those who passed through them.

The first scheme of this kind received the consent of Parliament in 1663, and dealt with ways in Herts, Cambs, and Hunts. It was not, however, until 1706 that the first Turnpike Act proper was passed. This proved so successful that, altogether, over 1,100 turnpike trusts were created in England and Wales, having under their control 23,000 miles of road and enjoying and spending a gross annual revenue of £1,500,000. Each trust was empowered to

construct and maintain a specified piece of road and to levy tolls for a limited period, usually twenty-one years. The powers were renewed from time to time, and Parliament further permitted the Surveyor of Turnpike Trusts to require the performance on the roads under his charge of the unpopular and personal obligation of Statute Duty and Team Labour first sanctioned in 1555.

The friction caused by the erection of turnpikes and the imposition of tolls led to much disorder, and culminated in the notorious Rebecca Riots in South Wales. In the meantime, general Acts were passed authorising the punishment by whipping and, in 1734, even by death of offenders who destroyed gates or toll-houses; but the state of friction continued until Parliament adopted a recommendation of a Select Committee of the House of Commons made in 1864, and finally declined to renew Turnpike Continuance Bills. The Highways and Locomotives Act, 1878, provided that such roads should become main roads, the expense of repair being jointly defrayed by quarter sessions and by grants from the Consolidated Funds. These roads are now under the care of the county councils.

It is greatly to be regretted that, by an obvious oversight, Parliament, when abolishing turnpike trusts, did not take steps to ensure that their records should be handed over to quarter sessions. It was enacted that the special powers of the trusts to abate encroachments should be continued; but the plans and records of the trusts, which were essential to prove the existence of such encroachments, remained with private individuals to whom they were useless. Such records have a definite historic value, and should be in the keeping of the county authorities. They throw much light upon economic problems of the eighteenth and nineteenth centuries, and are of considerable public interest and utility. County councils should therefore be empowered to acquire these records, on the ground that they concern all the main highways in the country, many of which have been public roads since their construction by the Romans.

Time does not permit me to describe the gradual development of the civic responsibility for the maintenance and preservation of secondary and other highways. On this subject many Acts of Parliament have been passed; indeed, so numerous have these become that authoritative works of reference upon highway laws give extracts from over fifty. A great public service would be rendered if these Acts could be consolidated into one comprehensive Statute.

It may be permissible to express the hope that a group of the barristers who doubtless have recently volunteered for some form of National Service may be deputed to perform this practical and useful task.

Few of us, perhaps, realise the vast expenditure entailed in the upkeep of public roads in England and Wales. For the last normal year before the war it amounted to over ten and a half million pounds—a sum which considerably exceeds the total revenue of Denmark. The burden of repair is increasing rapidly. Since 1907 it has grown by 11½ per cent. The total length of roads repaired by local authorities already amounts to not less than 151,112 miles, and if, and when, the recently proposed schemes of arterial road construction materialise, to meet the growing needs of speedy motor traffic, it is clear that the State will have to bear a considerable share of the financial burden.

It is now necessary to invite you to consider what is perhaps the most important and interesting aspect of the subject—the protection of public rights of way from obstruction. We have seen that once a highway has been dedicated to the public it can only be lawfully closed by Act of Parliament or justices' order. To obstruct it by any other means is unlawful, for the obstruction of a public way is a nuisance. We are all familiar with the maxim, "Once a highway always a highway," which is based on a decision that no length of time can legalise a public nuisance (*Rex* v. *Cross*, 3 Camp. 227).

Theoretically, therefore, a highway of any kind once created can never be lawfully closed by the irregular action of any individual. This principle has held good for generations, but prior to the reform of local government effected by the Local Government Acts 1888 and 1894, the burden of protecting rights of way was not obligatory upon a local authority, but mainly depended upon the voluntary efforts of the village Hampden. The power of the cumulative vote enabled one or two owners to disregard the needs and wishes of the inhabitants of an entire parish in vestry assembled.

For many years the Commons and Footpaths Preservation Society had found it necessary to include in its programme the work of preserving public rights of way, and the National Footpath Preservation Society, formed in 1884 by the late Mr. Henry Allnutt, also did much useful work.

The need for outside action was great, espe-

cially in the neighbourhood of large towns. Footpaths were being closed on every hand. In the meantime, appreciation of the unspoilt beauty of our countryside was slowly spreading, a certain sign that people even in a material age, if given a fair chance of elevation, will rise above the sordid and unnatural conditions of city life. Rambling clubs came into being with the object of encouraging fieldpath walking. They were helped by many footpath guides, the most comprehensive of which were to be found in the invaluable series of "Field Path Rambles" issued by the late Mr. E. S. Taylor (Walker Miles). In the meantime, the Commons and Footpaths Preservation Society organised many branches, including special committees to watch over the counties of Kent and Surrey, and Middlesex, Herts, and Bucks. It was felt that such committees were needed, having regard to the extraordinary rapidity with which the Metropolis was stretching away into the green fields of the home counties, dotted with commons and covered with a network of footpaths which, in the picturesque simile of the late Miss Octavia Hill, made meadows, fields and woodlands one vast park open to all, until the hands of the builder actually descended upon them.

The deep human interest, shrewd commonsense, and practical sympathy and enthusiasm of Miss Hill were placed whole-heartedly at the service of the Society and its Kent and Surrey branch, and were assets of the utmost value to the work.

These county committees were most fortunate, too, in having as their first chairman the late Sir Robert Hunter, whose unique knowledge and experience of the intricacies of the law of commons and highways, together with his zeal for the cause of public rights, were of infinite service to the movement.

In 1899 the National Footpaths Preservation Society was amalgamated with the Commons Preservation Society, and the work has so grown that, during the last twenty years, nearly 10,000 cases of obstruction of public roads, bridle-ways, and footpaths have been dealt with by the Society. Relatively few of these cases have concerned public carriage roads. Those highways are generally repaired at the public expense and, when that has happened, no question can arise as to the existence of a right of way. Only a small minority of footpaths, however, are repaired by the public, and disputes with regard to them are of frequent occurrence.

It is, therefore, fortunate that local authorities have far-reaching powers which, if wisely and fearlessly employed, render difficult, if not impossible, unlawful attempts to obstruct rights of way. Lord Eversley, the veteran president of the Society—the monument of whose fifty-one years of devoted and successful service in fighting the people's battles may be seen in the tens of thousands of acres of common land over which all may wander at will—succeeded in securing the insertion in the Local Government Act, 1894, of a drastic clause (26) with regard to rights of way. This clause declares it to be the duty of district and town councils, as highway authorities, to maintain all public rights of way within their area or in an adjoining district. They were directed to take any steps necessary to that end, including legal proceedings. In rural districts the Act authorised the parish council or parish meeting to put the highway authority in motion, and if it evaded its obligatory duty a power of appeal from the parish to the county council was given. Local councils have, therefore, ample facilities for vindicating public rights, but, in practice, it has frequently happened that they have failed to act. The reasons for their inactivity are manifold. Sometimes they fear a lawsuit with its attendant expense, trouble, and uncertainty; or they may be composed of persons who have no sympathy with the public point of view. Again, in an even greater number of cases, they may be influenced by the fact that many of their members work for, or are tenants of, the landowner who is endeavouring to shut up a public path. The power of territorial influence in a country parish is very real. In one typical case in which the Commons and Footpaths Society succeeded in securing and re-opening a public path, the aggressor was not only a magistrate, the patron of the church living and the lord of the manor, but the chairman of the district and parish councils, and a county councillor as well. Naturally, none of those bodies would enforce the law against him; and in this, and in thousands of cases of a similar kind, it has only been the force of popular opinion created, organised, and crystallised into action by the Commons and Footpaths Preservation Society that has led to the vindication of public rights.

A footpath has many enemies, and it is fortunate that it is a stubborn thing. Its origin may be lost even to tradition, but the path pursues its way with odd twists and turns which now appear meaningless, but which, in former days, enabled the wayfarer to avoid morasses, ponds, trees, or other natural obstructions which

have long since disappeared. The path at one time probably led to a now-forgotten shrine or chapel or well, and it certainly came into use to meet a local need. At the moment it may be valued only by ramblers and nature study enthusiasts, but that affords no reason why it should be arbitrarily closed. The ebb is followed by the flow, and paths which to-day may be of little value in the utilitarian sense may to-morrow become of much importance, especially now that the motor-car absorbs the country lane as well as the great main roads.

When a right of passage over a path which has hitherto been open is challenged, the first step which must be taken is to ascertain and marshal the facts both for and against the popular claim. A public path has certain definite characteristics. As a rule, it is provided with stiles, wicket, or other gates and footbridges; it is often a short cut, and it must be a thoroughfare leading from and to a place where the public have a right to be. Above all, it is desirable to be able to prove that the path has, in fact, been used for a long time as a public way by all who have desired to traverse it. Records, such as tithe or inclosure awards, sale plans, or ancient maps may be available to prove the antiquity of the way, although in view of recent decisions many maps are not admissible as evidence unless the surveyor by whom they were made can be produced to prove them.

Unfortunately, up to the present, Parliament has prescribed no fixed period of years of user for establishing a public as distinguished from a private right of way. The period varies in accordance with the views of particular judges, and with all the circumstances in connection with the formation, location, and history of the path. In one metropolitan case (*North London Railway Company* v. *Islington Vestry* (1872), Q.B. 37, J.P. 341), the brief period of eighteen months' user was deemed to be sufficient to support the presumption of dedication. In others, as we shall see, evidence stretching back as far as the oldest men can recollect has been held to be inadequate. It is, therefore, desirable to aim at securing evidence of forty or, if possible, of sixty years' duration.

Assuming that inquiry has proved satisfactory upon these points, and that no adverse evidence has come to light, it is fairly safe to conclude that the path in question is, *prima facie*, a public right of way. But it must not be forgotten that, in the case of most ways which have been challenged, evidence of some sort is also available on the owner's side, and it is of extreme importance that this also should be ascertained. As we have seen, public paths were not created by user. They originated in dedication, and, save in the rare cases where "express" dedication is capable of proof, it is necessary to establish a chain of facts so strongly in favour of the public contention that a judge will hold that the only fair inference or presumption to draw from those facts is that some owner, at some time or another, intended to dedicate a right of way. Such an inference may manifestly be rebutted if the owner can produce evidence of steps taken to protect himself from the presumption of dedication. Sometimes he has erected and maintained notices clearly indicating that persons using the path have done so with his permission; at other times he has closed the path once a year; or, again, he may have issued permits for the use of the path. The owner may easily and fully protect himself by steps of this nature from the risk of having a revocable licence transformed into a right against himself.

But, as a rule, obstruction, like dedication, is a gradual process, and the form of obstruction most to be feared is of a surreptitious nature which affords an unscrupulous landowner many opportunities for building up a case against the public. His first step will probably be to discourage the use by his own tenants and employees of a path he seeks to close. A frequent excuse is that he wishes to establish game preserves and desires privacy. In a country village, where the cottages all belong to one owner, it is almost impossible for the tenant to ignore the wishes of his landlord. I have known instances in which a man has been summarily ejected from the home of his fathers because his conscience would not permit him to acquiesce in the unjustifiable and unlawful obstruction of a public path. Such landlords are, fortunately, few in number.

Another favourite device is to erect notice-boards warning trespassers or boldly denying the right of way. Sometimes notices are of a more intimidating nature. "Beware of the bull" is often met with; while near Uxbridge a fearsome notice warning pedestrians to "Beware of the Red Bloodhound" may be seen. Close to Croydon, too, there is a wood, happily crossed by several beautiful public paths, where notices warning pedestrians against mantraps and spring guns are still displayed, although the use of such barbarous engines has long been illegal.

These wooden falsehoods, as they have been aptly described, are difficult to overcome, for, as an eminent judge once said, "A man is entitled to erect on his own land as many lies as he likes, provided they are not libels." The best remedy for this form of attack is to urge the district council to erect finger-posts under the powers conferred upon them by the Highway Act, 1835.

Sometimes, too, the path is obliterated and rendered inconvenient by ploughing. The rule is that a path cannot be lawfully ploughed unless it was originally dedicated subject to the reservation by the owner of the right to plough. Proof of that reservation exists when the path has been regularly ploughed up in the ordinary course of husbandry in the past (*Harrison* v. *Danby*, 34 J.P. 759).

Another method is to place barbed wire at the sides of a path in such a manner that pedestrians using the way run the risk of injuring their persons or clothing. If the wire is, in fact, a danger it should be removed as a nuisance at the instance of the highway authority under the Barbed Wire Act, 1893, and damages for injury may be obtained (*Stewart* v. *Wright*, 9 Times L.R. 480).

Some persons do not hesitate to put bulls or other savage animals in a field through which a public path passes. They have no legal justification for action of this kind, and in one case (*Lowery* v. *Walker*, L.R. (1911), A.C. 10) the House of Lords decided that a man was entitled to damages for injuries inflicted by a horse while he was following a footpath not dedicated as a public right of way, but which was habitually used by the public to the knowledge of the owner as a short cut to the railway station.

Many a path, too, has been gradually lost because the stiles and gates are inconvenient or have been allowed to become defective; because footbridges or stepping-stones have disappeared, or because, for lack of a little attention, the tracks have become water-logged or overgrown.

It cannot be denied that a stile perched on the top of a bank may become a serious obstruction when footboards are removed, or when the whole structure decays.

It is not generally known that the poet Cowper evidently intended to add to his "Diverting History of John Gilpin" an account of Mrs. Gilpin's trials on a journey by footpath to Edmonton. The three stanzas which were found in the poet's handwriting may be quoted, as they describe the predicament of many pedestrians who have endeavoured to surmount an awkward stile:—

> Then Mrs. Gilpin sweetly said
> Unto her children three,
> "I'll clamber o'er this style so high,
> And you climb after me."
>
> But having climb'd unto the top
> She could no further go,
> But sate, to every passer-by
> A spectacle and show,
>
> Who said, "Your spouse and you this day
> Both show your horsemanship,
> And if you stay till he comes back,
> Your horse will need no whip."

It is, *prima facie*, the duty of district councils to repair all public highways (including footpaths, but not main roads) known to have been in existence before the Highway Act, 1835, became operative, unless the burden of repair, *ratione tenuræ* or *ratione clausuræ*, falls upon the occupier of the land through which such ways pass. The councils can and should keep public paths in a reasonable state of repair, and if stiles are allowed to degenerate into such a condition that they are a hindrance to passage they should be dealt with as obstructions. Parish councils, too, are entitled to repair footpaths which are not situate at the sides of public carriage roads, and the Local Government Board have decided that they may also repair stiles and gates, although, in a technical sense, such erections are part of a fence and not of the highway. As to the nature of the repairs the law holds an even balance. The council must not decrease the height of a stile or put a wicket gate in its place if the owner raises objection, because by so doing it would be encouraging a greater number of persons to use the way. On the other hand, the owner may neither make a stile less convenient nor erect one where none previously existed, because if he did so he would be diminishing the public right. In the latter event, too, he might interfere with perambulators, for it has been laid down that the homely perambulator may be wheeled over a footpath, provided it is not of such size and weight as to injure the soil or inconvenience pedestrians, the justification being that a perambulator is a usual accompaniment of a large class of foot-passengers (*R.* v. *Mathias* (1861), 2 F. and F. 570).

Field-paths are of so much advantage to the community that it should be the aim of every council to maintain those within their area in a reasonable condition. They must not, without consent, metal a path which has not previously

been repaired, or they may find themselves in the unenviable predicament recently experienced by a Berkshire parish council, which was served with a writ by an irate owner because it had innocently ventured to put down a little stone in holes in a meadow-path, in order to enable the village children to reach their school dry-shod. But they can, in practice, do all that is required to prevent a path from vanishing through disuse.

The public should be on their guard against the unauthorised diversion of rights of way. It sometimes happens that diversions are effected without a magistrate's certificate. The new path is quite as convenient as the old, and no objection is raised to the change. But disputes have been decided against the public largely on this point, for it is argued that, since everyone is expected to know that certain elaborate formalities must be complied with before the line of a public path may be lawfully changed, acquiescence in an irregular diversion may be taken to indicate that the path was not a reputed public way.

Far more dangerous, however, is the temporary or permanent obstruction of rights of way. Gates are occasionally locked, stiles bushed up, or hurdles placed across the route. The occasional obstruction of footpaths is sometimes tolerated from a mistaken neighbourly feeling. In a protracted action about a path near Purley, one of the main factors which led to the loss of the way was evidence that it had been the habit of the occupier of the land during the lambing season to place hurdles to form a sheep-fold in a corner of a field through which the way passed. People merely walked around the fold, but much was made by judge and counsel of the fact that they had tolerated this temporary obstruction without demur.

Definite forms of obstruction are more easy to meet, because they are more apparent. Sometimes formidable barriers are erected, and I recently inspected a path which had been obstructed by the cutting of a dyke 12ft. wide and 7ft. deep. In a case in which the Commons Society was concerned, and which occurred at Snettisham (*Norfolk County Council* v. *Green* (1904), 90 L.T. 451), waggon loads of railway sleepers were conveyed to the spot and deeply embedded across the path. Moreover, barbed wire entanglements were introduced which might have served as a model for the Hun. They were all removed by the sturdy village fishermen, whose action was upheld by the High Courts.

It is not always safe for members of the public to take the law into their own hands by removing obstructions. In any event, it is imperative that they should be certain that the obstructed path is a public way, and that they should do no more damage than is actually necessary to secure reasonable passage. Courts of Law view with suspicion the acts of a private individua who seeks to remedy a public nuisance by physica force. For instance, a few years ago a membe of the Commons Society removed a locked gate which had been erected across a carriage-road. Proceedings were taken against him, and he proved that the road was a public way. Nevertheless, he was ordered to pay the costs, because he had removed not only the gate but also the iron staples in the gate-posts into which the hinges of the gate had been fixed. It was held that he had done more damage than was necessary.

It will thus be realised that an owner seeking to deprive the public of a right of way has available a variety of methods of attack; and he can slowly build up a case, even when an ancient path is involved, to show, by a series of repressive acts, that he did not intend to dedicate a way and to raise the presumption that his predecessors did not do so either. He has also the enormous advantage of knowing that, whether he is plaintiff or defendant, the burden of proof lies on the side which is championing the public cause. It is necessary for the public to show upon what they base their claim of dedication before the owner is called upon for a reply. To the layman, therefore, the fight is bound sometimes to seem unfair, especially since the tenants and employees of an estate, for obvious reasons, cannot be called as witnesses to support a claim of right against the estate, and that, even if they were willing to testify, their special knowledge would be of little service because their user of the path would be deemed to have been privileged.

And the owner has also other great advantages. We have seen that all public rights of way which were not created under statutory authority must, in legal theory, have originated in dedication, and that the process of dedication is tantamount to the free gift or grant to the public of an irrevocable licence to use such ways. The only person who can make this gift or grant is the absolute owner of the freehold. A person who enjoys a limited interest in the property is not the actual freeholder and, consequently, it is held that he cannot burden the estate in which he is interested by the grant of a perpetual licence or easement in favour of the public.

A great proportion of the land in this country is in the hands of tenants for life; it is strictly

entailed or subject to family settlements, and it may have been in that condition for hundreds of years. The tenant for life is not the actual freeholder, and, therefore, he cannot, in a technical sense, dedicate rights of way in favour of the public, save in the manner permitted under the Settled Land Acts. If a break, however brief, in the family settlements can be established, the difficulty disappears; but judges differ in their method of dealing with disputes about rights of way on land which has been strictly entailed throughout living memory. Some insist upon proof that the public enjoyed the use of the alleged way before the family settlements commenced. For instance, the late Lord Alverstone, when Lord Chief Justice of England, tried a case with reference to a disputed roadway on the Trentham Estate of the Duke of Sutherland. Evidence was produced of actual public user for eighty-five years; there was little rebutting evidence and the issue seemed clear. The jury returned a verdict to the effect that a public right of way had been obtained by long user, but that the present Duke had not intended to dedicate—a fairly safe rider seeing that the road was obstructed whilst he was owner. This verdict was set aside by Lord Alverstone on the grounds that the land had been strictly and continuously entailed since 1760; that he had no evidence of the public use of the way before 1760; and that, since that time, no dedication could be presumed to have arisen by mere user.

If it were followed by all judges, this strict view of the law would render impossible the proof of public paths on estates which were entailed before living memory. Fortunately, however, other judges got over the technical difficulty by holding, in cases in which there is ample evidence of public user throughout living memory, and in which the user cannot be shown to have commenced during the period of settlement, that dedication must have taken place before the period of entail began. Lord Justice Chitty, in the course of proceedings with regard to a Sussex path, adopted this attitude, and brushed aside a claim that no public right of way could be proved because the estate had been entailed since the time of William and Mary, by saying that, if necessary, he would presume that dedication took place in the reign of William the Conqueror.

This uncertainty in the administration of the law is a serious hardship to litigants. The owner does not know what attitude a particular judge may adopt with regard to what may be his strongest line of defence. On the other hand, local authorities fear to embark upon litigation, even in cases where the evidence is overwhelmingly in favour of the public, because the existence of an unknown family settlement may be sprung upon them at the last moment.

Accordingly, a widespread feeling has arisen on both sides that the proof of public rights of way should be placed upon a more equitable and sure basis. In the case of private ways no ambiguity exists, for under the Prescription Act proof of unchallenged enjoyment for forty years is sufficient to establish a claim to a private easement even against a settled estate.

The Commons and Footpaths Preservation Society have, therefore, ever since 1907 been pressing for an alteration of the law, and on their behalf a Public Rights of Way Bill has made several appearances in Parliament. This Bill proposes that where an estate is in the hands of an actual freeholder, open and notorious public user of a path for twenty years shall be sufficient to raise the presumption of dedication. If, however, the estate is entailed, or subject to any other technical disability, it is proposed that the period of user shall be forty years. This Bill has met with little opposition, for the justice of its principles is recognised and the need for its passage is generally admitted. In different sessions it has passed the House of Commons and House of Lords by overwhelming majorities, but the time available for the discussion of private members' Bills is so brief that the Bill has not yet been approved by both Houses in the same session. It may be hoped that when normal times again come the Government of the day may be prevailed upon to give facilities for the passage of this useful measure.

Another serious difficulty in maintaining rights of way has arisen from the divergent views of judges on the question whether a public footpath may lead to a place of historic interest or natural beauty, or whether it must lead to another public way. Many of our most cherished paths are valued because they give access to a mountain top or glen, to a cliff, or to a ruined castle. A beautiful view is a national asset. It may have been available to the community for centuries and beaten tracks worn by the feet of many thousands of tourists may approach it. Nevertheless, some judges hold that such paths are permissive, and that they may be closed to the innocent enjoyment of the public unless a through route can be maintained. It is surely illogical to contend that, whereas a public high-

way in a town may be a *cul-de-sac*, every public right of way in the country must be a thoroughfare.

In the case of a path leading to a mountain top in Cumberland, a public right of way was established with the help of the Commons Society, which also assisted in the legal fight which led to the reopening of a road to the Giant's Causeway in Ireland. Unfortunately, however, in the case of public access to Stonehenge, the Society was defeated in its attempt to establish a public right of access.

The caging in of Stonehenge by means of a barbed wire fence and the charge of one shilling admission to the enclosure aroused violent opposition, for this famous circle of stones is recognised as the most imposing and interesting of all the prehistoric remains in England. For hundreds if not for thousands of years this early cathedral of the British race had been approached by deeply scored roadways which cross the Wiltshire Downs for long distances. It was alleged that the stones were suffering damage; but the Society pointed out that if that were the case it was open to the owner, while retaining all his proprietary interests in the monument, to constitute the Office of Works guardians of Stonehenge under the Ancient Monuments Act, and they would thereupon be bound to protect the remains.

It offered to raise £10,000 in order to purchase the owner's rights and to protect the stones without enclosure. This offer was declined, although, after first asking an enormous sum for his interests, the owner came down in price to £50,000. The Society felt that it would be neither right nor possible to raise this exorbitant amount, and with great regret Lord Eversley and the Committee eventually decided to institute legal proceedings against the owner, Sir Edmund Antrobus, who had obstructed the ancient tracks.

The hearing lasted seven days, and finally the judge decided against the Society's claims: in the first place, because the existence of a long-standing settlement was deemed to prevent the presumption of the dedication of through routes; and, in the second place, because, in his view, a public way could not end at a place of historic interest, such as Stonehenge.

This has been the only case in which the Society has suffered defeat in the Law Courts during a fifty years' fight for public rights of way, and the sympathy aroused by its efforts to maintain an important public principle has determined it not to rest content until this point, too, is finally settled by Parliament in accordance with the dictates of common-sense and equity.

In the meantime the death of Sir Edmund Antrobus led last year to the sale of Stonehenge. The monument realised at public auction £6,600—or £3,400 less than the Society offered to raise in 1901 in order that the remains might be permanently preserved for the nation. Stonehenge is still in private hands, and the estate is considerably poorer than would have been the case had the Society's offer been accepted.

Litigation with regard to rights of way is an expensive matter. The Stonehenge case cost the Society almost £4,000; that amount, although large, is small in comparison with costs which followed a bitterly-contested action about Yorkshire footpaths, and which amounted to over £15,000. Heavy expense is unavoidable, because a host of witnesses must be produced on each side, and also because the cost of investigating ancient titles is often considerable. By simplifying the law, and laying down fixed rules for the guidance of judges and counsel, the Society's Public Rights of Way Bill will greatly reduce the burden of expense in connection with footpath litigation.

It must not be thought that the Commons and Footpaths Preservation Society is a litigious body. That is not the case, and very few of the thousands of disputes which have been brought to its notice have found their way to a Court of Law. It frequently happens that a representation to the landowner involved is sufficient to secure a recognition of the public rights. It is a pleasing duty, too, to bear record that most highway authorities are determined to perform their duty to the community in the matter. There are naturally exceptions to this rule, but the relations between the Society and parish and district councils are, in general, of the most satisfactory and cordial character, and many councils make it a practice to refer to the Society for advice in every case arising in their areas with regard to rights of way.

Nor should it be imagined that all landowners adopt the attitude of the autocrat who proudly said—

> "I am monarch of all I survey,
> My right there is none to dispute."

There are, it is true, too many owners who are willing to sacrifice public rights upon the altars of their private convenience, but the majority have come to recognise that the Society invariably endeavours to act with impartial justice to

both sides, and that it will not bolster up a weak or improper case. One happy result of this growing appreciation of the Society's principles and practice, has been that, during the last few years, it has often been asked to arbitrate between landowners and local authorities in cases of disputed rights of way. In its *rôle* of arbitrator the Society has been able to settle hundreds of vexatious footpath disputes to the satisfaction of the public and of the landowners, and at the present time disputes with regard to no fewer than 147 ways are awaiting adjustment at its hands.

By means of friendly settlements of this kind, legal proceedings, with all their attendant friction, expense and dissatisfaction, are obviated. Above all, the bitter memories which follow an unsuccessful footpath fight are avoided, for no feeling is created that might prevails over right.

Nevertheless, it is only by incessant watchfulness that our field-paths and woodland tracks are maintained. Gradually, through the efforts of the Society and its branches, footpath maps will cover a great part of the country. But this work is laborious and expensive, and, of necessity, it must proceed slowly and with care. In the meantime the cult for country rambling is growing in response to the facilities offered by rail, omnibus, and tram for rapid and cheap passage to the green fields. This development leads to fresh dangers, for experience has shown that a few irresponsible town-dwellers may render not only themselves, but the rambling community at large, unpopular with farmers when they wantonly trespass or ignorantly damage hay or other growing crops. Privileges, appreciated by many, may be withdrawn in consequence of thoughtless abuse by a few irresponsible individuals.

It may be, as Mr. Richard Whiteing suggests in his book "All Moonshine," that the time is coming when the development of aeroplanes may render unnecessary terrestrial tramps, but, as he takes care to add, the Commons Preservation Society will even then find it essential to open a Vault of Heaven branch.

In the meantime, it is estimated that there are in this country not fewer than 300,000 public paths. Each one of that great multitude is an asset of rural life, the preservation of which is worthy of some sacrifice. From the hour when the tender green of springtime first appears, to the closing months of the year when "autumn's golden arm enfolds the world," the charm of the footpath way acts as a magnet to the man whose heart is open to the touch of nature. The Commons and Footpaths Preservation Society, as the unofficial guardian of public rights and privileges, may also claim some share of his thoughts and sympathies in its ceaseless efforts to hand on to future generations those highways and byways which are now so great a boon.

DISCUSSION.

The Chairman (the Right Hon. Lord Farrer), in opening the discussion, said that, while our nation and its Allies were engaged in fighting for the freedom of the seas, the author was constantly fighting for the freedom of the land. One point mentioned in the paper had always puzzled him, namely, why was it that the Roman roads that existed all through Great Britain disappeared on the departure of the Romans? With regard to the author's suggestion that lawyers enrolling for National Service should be employed in codifying the various Acts dealing with highways, he was not sure that codification was always of advantage; and at any rate he thought it would be difficult to improve in that respect on the Act of 1836, which was a codification of the common laws and common customs of many centuries.

Mr. James Ellis referred to the fact that many of the old Roman roads were still in existence and being used at the present time. Men were gifted with faculties to appreciate the beauties of nature, and whether the author led them through field or forest, or highway or byway, he could show them where those beauties were to be found and could act as an ideal guide, philosopher and friend.

Mr. John Slater, F.R.I.B.A., said he had listened to the paper with very great interest. It seemed to him that if legally dedication was the first thing which gave a right to a footpath, surely user must have preceded it. The footpaths that were found all over the country must have been made by people who wanted to get somewhere, so that they must have had the user of them long before there was any dedication at all. With regard to the Chairman's remarks about the strange disappearance of the Roman roads, a similar case was that of the stately mansions erected in the time of Queen Elizabeth, many of which had completely disappeared. On the Continent also the Roman roads had vanished; he knew of a place in France where there was a beautiful archway which was evidently the entrance to a Roman way that had completely disappeared.

Mr. W. Whitaker, F.R.S., mentioned that the law with regard to cycling along public paths was rather singular, as cycles were looked upon as carriages,

with the result that a man might ride a horse along a path, but not a cycle. He would be glad if the author could say what was the essential width of a bridle path; it was mentioned in the paper that the public had a right from hedge to hedge, but if the hedges gradually grew nearer and nearer together the right was not worth very much. At Croydon there was an energetic branch of the Commons and Footpaths Preservation Society, whose members recorded on a map all the stiles and signposts and gates that they encountered on their walks, and he thought that plan might be followed in other parts of the country in order to avoid the setting up of obstructions. It was the duty of the public to help in the preservation of their rights; if they did not, those rights would be lost to them. The author had given several instances of cases where rights of way had been lost simply for want of being looked after, and he hoped people would take warning from that, and give their support to the Commons and Footpaths Preservation Society. He thought it was not sufficient merely to put up a sign indicating that a certain footpath was public, but there should also be a notice indicating the place to which the path led.

Mr. Randolph A. Glen said that, with reference to the question of dedication, he did not think the author had made it clear that in dedication there were two things. There must be an intention on the part of the owner to dedicate, and there must also be user by the public, which meant acceptance by the public. The theory was that the owner said to himself, "I will allow the public to cross my land between two points," and that the public then went between those two points and made a track on the ground. What happened in practice, however, was that the public wanted to travel between two points; they saw a convenient place to cross at, and in crossing they made a track on the ground. Subsequently the owner saw the track, and if he did not take steps to prevent the use of it, he was presumed to have intended from the commencement of the public user that the public might go that way. The Courts did not pay any attention to the actual moment of the commencing of the user or the actual moment of the intention to dedicate. With regard to the codification of the law relating to highways that the author advocated, he did not think that was necessary, as the law was quite plain at the present time. He thought what was required was an amendment of the law, as set forth in the Rights of Way Bill. Codification was not so much required as the abolition of the ridiculous rule with regard to strict settlement. The real hardship from which the public were suffering was that they lost their right simply because for many years the landowner had been a person who was unable to dedicate because of that strict settlement. In Scotland at the present moment only forty years' user had to be proved in order to establish a right of way, and the Commons and Footpaths Preservation Society wanted that law to be applied to England as well. If the owner of the land at the time was also the freeholder and able to dedicate, the period should not be forty years, but twenty years.

On the motion of the Chairman, a vote of thanks was accorded to the author for his interesting paper.

Mr. Chubb, in reply, after thanking those present for the cordial reception they had given to his paper, confessed that he could not offer a satisfactory answer to the Chairman's question with regard to the disappearance of Roman roads, as he had never been able to understand why those roads had disappeared. The failure of the system of ordered government which followed the withdrawal of the Romans, and the cessation of the use of roads by chariots, might have tended to obliterate the surfaces of the roads, and their destruction was accelerated, at all events in some places, by the removal of the valuable materials which formed the deep highways for the purpose of making fences and walls, and even buildings. It was remarkable that they had disappeared, but he thought it still more remarkable that many of them had disappeared quite recently. There was, unfortunately, no statutory width laid down for a bridle path, a footpath, or a carriage road that did not lead to a market town; it depended on the width that the public had actually used in the past. There were certain stipulations with regard to the width of paths leading to market towns, in order that the surveyor of highways might have authority to clear away obstructions at the side of those paths. The reason why a cyclist was not entitled, strictly speaking, to ride along a bridle path was that a bridle path was a highway limited to the use of foot passengers and horsemen. There was seldom any objection raised to a cyclist using a bridle path, but in a technical sense a cycle was deemed to be a vehicle. He hoped all those interested in the subject of his paper would constitute themselves unofficial guardians of the public right of way.

RED PEPPER TRADE OF SOUTH INDIA.

According to a report by the United States Consul at Madras, the Presidency of Madras is by far the largest producer of chillies (red pepper) in India proper, followed ordinarily by Bengal and the Punjab. The area devoted to this culture cannot be stated definitely, as the plants are most frequently raised as borders to fields or as lines through fields. In Eastern and Northern Bengal, however, capsicum becomes a regular field crop. In the Madras Presidency chillies are raised for commercial purposes principally at Guntur, Nellore, Erode, Salem, and

Ongole, where the plant thrives best in irrigated lands. The commonest form is the *Capsicum annuum*, to which the Bombay, Japan, and other long capsicums belong. The surplus crop of chillies, or that not used for domestic consumption in the fresh state, is dried and exported.

The name "Bombay capsicum" has become applied to nearly all red pepper exported from the west coast, even though the product may have originated in the Madras Presidency. This variety is 2 in. or 3 in. long, with a thick skin and a heavy stem. It is usually the cheapest grade available for grinding and, when bright-red, clean pods are secured, will produce a good coloured powder of considerable strength. The Bombay capsicum is mixed with mombessa and other strong chillies by many grinders to produce a strong ground red pepper at a moderate price.

The shipments to all countries in the fiscal year ended March 31st, 1915–16, amounted to 8,050,911 lb., valued at £102,100. The yearly crop in South India is estimated at about 4,000 tons. In India red pepper is much used as an ingredient in all curries and many other food preparations by every class of the community. In Bengal an extract of the consistency of treacle is regularly prepared and sold. The green fruits are pickled or cooked fresh with special dishes, and even eaten raw.

LAKE COLERIDGE WATER-POWER SCHEME: FIRST YEAR'S OPERATION.

The results attained by the Government scheme for the development of hydro-electric power from Lake Coleridge, which has been in continuous operation for a complete year, have, according to the Public Works Statement for 1916 of the New Zealand Minister of Public Works, justified the most sanguine anticipations. The lake, which is some ten miles long, is situated in the Canterbury Province, in the basin of the Rakaia River. Three units of generating machinery were originally installed, capable of an output of 6,000 h.p. Twelve months ago the demand for current warranted the installation of a fourth unit of 2,000 h.p., and the expanding business now necessitates the addition of a fifth unit, comprising pipe-line, turbine and generator of 4,000 h.p. During the year the maximum load on the plant reached 1,770 h.p., which is less than the capacity of any one of the units installed. Under these circumstances the business could not be expected to show a profit, but, on the other hand, at the end of the year the plant was earning sufficient to cover working expenses. Contracts to the extent of 8,000 h.p. have already been entered into, and when the power under these contracts is being supplied it is confidently expected that the plant will be earning sufficient to pay interest in full as well as working expenses.

The power has, up to the present, been utilised mainly for public (lighting, etc.), domestic and certain industrial purposes; further arrangements are now in hand for utilising the current for tramway traction and for the operation of machinery in the principal meat works, flour-mills, tanneries, dairy factories, and the established industries in and around Christchurch. During the year feeder lines have been extended to Belfast, and arrangements are being made for a further extension in that direction to Kaiapoi.

In addition to supplying power for present known requirements the Department of Public Works is in touch with manufacturers in many branches of industry with a view to introducing new processes or improving existing ones where such possibilities are opened up by the large supply of electric power available. It is probable that one result will be the establishment of new electro-chemical industries, and possibly the manufacture of steel.

ARTS AND CRAFTS.

Arts and Industry.—Some time ago the council of the Imperial Arts League drew up a memorial which was sent to the Commercial and Industrial Committee presided over by Lord Balfour of Burleigh. In response to the Committee's request the League has now sent a further memorandum setting forth the necessary connection between art teaching and manufacturing interests, and offering certain practical suggestions with regard to the organisation of the teaching of industrial art in this country. The document will, doubtless, be regarded very differently by people of various schools of thought, and possibly even those who are in sympathy with its views and aspirations as a whole may doubt whether the foundation of an independent "Industrial Art Department," "working in conjunction with the Board of Trade and the Board of Education," would necessarily be a very effective measure of reform or would be the best possible means of furthering industrial development along sound artistic lines. However that may be, the council of the Imperial Arts League must be counted as having done real service to the nation at this juncture in bringing forward a scheme in which they insist, sanely and firmly on the importance to trade and manufacture of high ideals in taste and the necessity for linking up the art schools in industrial centres with the industry of the locality and the close connection between technical and art training. The recommendation that South Kensington should augment the extent and distribution of its travelling collection will be welcomed by many teachers, and the reminder that the Victoria and Albert Museum was founded for designers and manufacturers is one which, in view of

much common talk, needs repeating and emphasising. The suggestion that "permanent and properly-housed Industrial Exhibitions of examples of modern industry" should be established is not, of course, new, and most of us remember attempts somewhat in this direction which have not been entirely successful; but there seems no reason why difficulties of this kind should be allowed to stand in the way of what might be a really useful institution. There is urgent need at the present moment for impressing both upon artists and manufacturers in the interests of our national trade and industry now, and still more after the war, the intimate relation between art and manufacture and the services which they can render to one another. If the importance of this matter has been brought home to the Commercial and Industrial Committee a very great deal has been gained.

Graphic Arts and War Memorials at Burlington House.—The Winter Exhibition of Graphic Art at the Royal Academy is worthy of more attention from the point of view of Arts and Crafts than might be expected from a collection with such a title housed at Burlington House. Besides the very interesting retrospective section, it contains drawings, wood engravings, etchings, dry points, aquatints, mezzotints, lithographs and colour prints by the principal graphic artists of the day, and it shows incidentally the kind of work which is available for various trade purposes. Not only can the publisher discover from the exhibits where to obtain illustrations and book decorations of various kinds, and what is being done by artists of widely different schools and concerned with a variety of techniques, but the business man, with an eye to the production of a really good and artistic catalogue, showcard or what not, will find much that is of use to him. There are examples, too, of designs for certificates and the like which are of interest from a decorative standpoint. Apart from purely practical considerations, it would be difficult to overestimate the value of the exhibition as throwing light on recent developments in the graphic arts, showing how much has been achieved recently both technically and artistically, and helping the general public to realise the influence of such comparatively modern artists as Whistler, Beardsley and Phil May, as well as masters of a rather earlier date, upon present-day work.

One section of the exhibition is devoted to designs for war memorials. These are largely sketch models on a very small scale for large and imposing monuments to be erected by corporations and public bodies, and it is rather difficult to judge from them just how far the finished work would or would not be successful, though some of them show considerable promise. Amongst the rather less ambitious exhibits, Mr. W. Reynolds-Stephens's little kneeling angel, suggested as a memorial to one of our fallen heroes, may be noted as peculiarly charming and attractive. Mr. Alfred Drury's war medal is a dignified piece of work, and some of Mr. Nelson Dawson's small memorials are, in their characteristically massive way, of real artistic interest. One or two of the designs for wall tablets to be erected in memory of eminent men suggest the reflection that such work is not always best carried out by artists distinguished in some other branch of art, even if they happen to have some care for decorative effect.

The Mace for the Dominion House of Commons.—It is both fitting and graceful that the new mace for the House of Commons of the Dominion of Canada should be presented to that assembly by the Lord Mayor of London (Sir C. C. Wakefield) and the Sheriffs who were in office when the Parliament House at Ottawa was burnt down. There is also a good sentimental reason for keeping the design of the new mace on similar lines to those of that used in the House of Commons of the Mother Country, with such differences as are entailed by the necessity for including the arms of Canada and the desirability of introducing such emblems as the maple leaf and the beaver. This close adherence to the old form has resulted in the production of a very handsome and dignified piece of plate worthy in many respects of both the donors and the recipients, and creditable to the Goldsmiths and Silversmiths Company whose work it is. From the point of view of the encouragement of British art and the expression of more modern feeling one cannot help thinking that an opportunity has been lost. There is nothing about the mace which suggests a vigorous modern art movement in this country. A choice had to be made between two opposing sets of ideas, and it is quite possible that it was wisely made and that the Dominion House will be better content that their mace should be very much like the British one than that it should represent the artistic ideals of the present day. Whether British artists will agree with them is quite another matter.

OBITUARY.

The Duke of Norfolk, K.G., G.C.V.O.—The Duke of Norfolk died at his residence in St. James's Square on the 11th inst. at the age of sixty-nine.

Born in 1847, he succeeded his father, the fourteenth duke, in 1860, and in the same year he began his school life at Cardinal Newman's school at the Oratory. At the age of seventeen (as Roman Catholics were at that time debarred from attending the universities) he was sent to travel, and he stayed for a considerable time

with his uncle, Lord Lyons, then Ambassador at Constantinople.

While still a young man he began the work for his co-religionists which was to last to the end of his life. He came to be known abroad as the lay representative of the Roman Catholic Church in England, and as such he was selected as the natural leader of the special mission to the Pope which took place in 1887.

The Duke's public services, national and municipal, were many and various. In 1895 he was appointed Postmaster-General under Lord Salisbury's Government—an office which he resigned in 1900 in order to volunteer for active service in the Boer War. He frequently sat on Royal Commissions, and took a continuous and deep interest in his work in the House of Lords, although he did not again accept office.

He served as Mayor of Sheffield, where he owned a great deal of property, from 1895–1897. In the latter year the Mayoralty of the city was raised to a Lord Mayoralty, and the Duke thus became the first Lord Mayor of Sheffield. His benefactions to the local parks and recreation grounds were on the grand scale, and he also took a leading part in the establishment of the University of Sheffield, of which he was the first Chancellor.

As hereditary Earl Marshal, the Duke held a post for which he was peculiarly suited, for he was keenly interested in public ceremonial, and he was responsible for the arrangements at the coronations of King Edward VII., and of his present Majesty.

The Duke became a Fellow of the Royal Society of Arts in 1914, on the nomination of Lord Sanderson, who had just retired from the Chairmanship of the Council. He was at once elected a Vice-President of the Society, and he continued to hold this office until his death.

FREDERICK WILLIAM HARRIS.—The death occurred at Bournemouth, on the 2nd inst., of Mr. Frederick William Harris, Chairman of Messrs. Harris & Dixon, Ltd., in his eighty-fourth year.

At the age of twenty-one, Mr. Harris was admitted a partner in the firm of Bentley, Harris & Dixon. He was one of the founders of the Commercial Union Assurance Company, and remained a director of this company and a member of Lloyd's until his death. At one time he was deeply interested in the development of the South Wales coalfield, and he sank Harris's Deep Navigation Pits, which are now amalgamated with the Ocean Collieries. He was a Lieutenant of the City of London, a member of the Council of the University College of South Wales, a Past-Master of the Drapers' Company, and for many years Chairman of the Coal Factors Society.

He was elected a member of the Royal Society of Arts in 1897.

GENERAL NOTES.

DECLINE OF SHEEP-FARMING IN SWITZERLAND.—According to a statement recently made by a member of the Swiss Federal Council, it appears that the total number of sheep in that country has decreased, during the last fifty years, from 4,500,000 to 1,710,000 head. It was considered that steps should be taken by the Federal Government to encourage sheep-farming and take immediate steps to provide against a scarcity of meat in that country.

POTASSIUM CHLORIDE IN JAPAN.—The output of potassium chloride in Japan is now sufficient to meet the home demand. The annual consumption of potassium chloride in Japan is about 4,000 tons (according to the *London and China Telegraph*), the greater part of which was supplied, prior to the war, by Germany and other European countries. Since the war broke out prices have increased five-fold. Stimulated by high prices, many new potassium-making companies have been established in Japan. Whereas before the war there was only one Japanese chemical company, which was producing three hundred tons a year, there are now a number of companies largely engaged in the manufacture of this product in the Hokkaido, Awa, Kadzusa, Shimosa, and other districts, and official statistics show that at present the output is over 3,500 tons. Since August last considerable export business has been done to Vladivostock, China, and Sourabaya. Thus, 302,512 lb. were exported in August and 231,756 lb. in September.

A MERSEY TRAFFIC TUNNEL.—The project of constructing another tunnel under the Mersey between Liverpool and Birkenhead has been revived. There are two schools of opinion on the subject, says the *Times*, one favouring a traffic tunnel and the other advocating a great bridge. Sir William Forwood, in urging that a traffic tunnel is necessary, estimates that it would cost £1,200,000, with tracks for both slow-moving and fast traffic, but would be less expensive than a bridge as a means of relieving the enormously-developed cross-river goods traffic. It is pointed out that the congestion and delay in this traffic under present conditions is bearing hardly on the trade of the port, and that something will have to be done to provide permanent relief, especially in view of the future growth of Liverpool's trade. Sir William Forwood suggests that a tunnel might be approached by a subway with a gradient of, say, 1 in 20, a spiral roadway descending at that gradient 120 ft. or 150 ft. to the mouth of the tunnel. Such a spiral would not occupy more than an acre of land, and there is ample room for its construction at the pier head. The centre of the spiral might be used for passenger lifts, but passenger traffic could also be conveyed in motor or electric trains.

Experiments in the Rearing of Blue Foxes.—An arrangement has been made between the Bureau of Fisheries of the United States Department of Commerce and the Bureau of Biological Survey, Department of Agriculture, for experimental work in the rearing of blue foxes. The Fisheries Bureau will supply the Biological Survey Bureau this season with six pairs of blue foxes from the Pribilof Islands, Alaska, for use on a fox farm in the State of New York. The price commanded for blue-fox pelts naturally makes the question of the possibilities in the way of breeding the blue fox in captivity of considerable interest. The problem has been undertaken by various persons in different regions, but the Bureau of Fisheries is not aware that definite results have been obtained. It is hoped that the work of the Biological Survey in this respect will develop methods for successfully rearing this animal in captivity from the standpoint of a profitable fur-producing business.

Bauxite Deposits in Dutch Guiana.—From a report by the United States Consular Agent at Paramaribo, it appears that bauxite was discovered in 1915 by a mining engineer on private properties situated on the Surinam River, four hours' journey from Paramaribo. The area over which the bauxite deposits have been found, and which discloses various outcrops, is sixty-two miles long and six and a quarter miles wide. It is not yet possible to give any idea of the amount of bauxite within this area. Very little prospecting has been done. In wet, tropical countries like the Guianas there is extensive decomposition. The damp heat, aided by decomposed vegetation, tends to make surface indications difficult for the prospector. On the northern fringe of the deposit there is a large percentage of iron, assays showing as high as 33 per cent., whereas the southern fringe shows less than 2 per cent. Silica contents are low at both points. It is probable that the greater part of the given area is made up of bauxite, and that the mineral will be discovered at various depths, the formation being of a wavy nature. Several broad and deep rivers run through the course of the formation, making it easily accessible for transportation.

MEETINGS OF THE SOCIETY

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

February 21.—Mrs. C. Hoster, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment." Lady Emmott will preside.

February 28.—Francis A. Hocking, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs." Robert Hutchison, M.D., F.R.C.P., will preside.

March 7.—James Harris Vickery, LL.B., "German Business Methods."

March 14.—Dr. J. Augustus Voelcker, "Fertilisers and their Supply in War Time."

March 21.—G. W. Jones, "Colour Printing and some Recent Developments." Carmichael Thomas, Chairman of the *Graphic* and *Daily Graphic*, will preside.

April 18. — Horace M. Thornton, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

April 25.—Sir Francis Fox, M.Inst.C.E., "Flour and Bread." Captain Charles Bathurst, M.P., Parliamentary Secretary, Ministry of Food, will preside.

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

March 15.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

April 19.—D. T. Chadwick, I.C.S., "The Future of Indian Trade with Russia and France."

May 17.—Surgeon-General Sir C. Pardey Lukis, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

February 27. — Alfred Bigland, M.P., "Imperial Assets and how to use them."

March 27.—The Hon. Frederick W. Young, LL.B., Agent-General for South Australia, "Land Settlement in South Australia."

May 1.—Philippe Millet, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

Joseph Pennell, "The Artistic Aspects of War Work."

Gabriel Gordon Cleather, "The Drum."

Dr. M. Horn, "The Belgian Colonies."

Professor William Ripper, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency."

Cantor Lecture.

Monday afternoon, at 4.30 p.m.:—

PROFESSOR A. BERESFORD PITE, F.R.I.B.A., Royal College of Art, South Kensington, "Town Planning and Civic Architecture." Four Lectures.

Syllabus.

LECTURE IV.—FEBRUARY 19.—*The Housing and Town Planning Act*, 1909. Problems for solution. Procedure. Advice to promoters. Preparation of schemes. Architectural considerations. Examples of Garden City movements—Letchworth, Hampstead, etc. The problem of London.

Howard Lectures.

Monday afternoons, at 4 p.m.:—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies: (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market." Two Lectures.

April 30, May 7.

Aldred Lectures.

Monday afternoons, at 4.30 p.m.:—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

March 5, 12, 19.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Cantor Lecture.) Professor A. Beresford Pite, "Town Planning and Civic Architecture." (Lecture IV.)

Victoria Institute, Central Buildings, Westminster, S.W., 4.30 p.m. Dr. T. G. Pinches, "From World Dominion to Subjection: the Story of the Fall of Babylon."

Bibliographical Society, 10, Hanover-square, W., 5 p.m. Mr. G. F. Barwick, "The Laws regulating the Book-Trade in Italy."

Chemical Industry, Society of (London Section), at Lyon's Birkbeck Café, High Holborn, W.C., 7.15 p.m.

Geographical Society, Burlington-gardens, W., 5.30 p.m. Mr. H. C. Woods, "The Baghdad Railway and its Tributaries."

TUESDAY, FEBRUARY 20...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor J. S. S. Brame, "Liquid Fuel and its Combustion."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Dr. J. Brownlee, "The Relation of Infantile Mortality to Mortality in Subsequent Life."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Pain and its Nervous Basis." (Lecture VI.)

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. F. J. Norman, "Period Furniture and Upholstery."

Photographic Society, 35, Russell-square, W.C., 7 p.m. 1. Mr. B. Cox, "Some Observations on Clouds." 2. Mr. T. H. B. Scott, "Some Observations on Photographers."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. C. J. C. Pool, (*a*) "Notes from the Caird Insect House, with exhibition of specimens and lantern-slides"; (*b*) "The Coleoptera of the Family *Cissidæ* found in Britain, with Descriptions of two new Species. A new Species of the Coleopteran genus *Cryptorrhynchus* Illiger." 2. Mr. A. de C. Sowerby, "On Heude's Collection of Pigs, Sika, Serows, and Gorals in the Sikawei Museum, Shanghai." 3. Mr. G. A. Boulenger, "On the Lizards of the genus *Philochortus* Matschie."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Discussion on Mr. G. W. Humphreys' paper, "The Main Drainage System of London." 2. Mr. J. L. Hodgson, "The Commercial Metering of Air, Gas, and Steam."

WEDNESDAY, FEBRUARY 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mrs. C. Hoster, "The Training of Educated Women for Secretarial and Commercial Work, and their Permanent Employment."

Aëronautical Society of Great Britain, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain G. S. Walpole, "The Less Satisfactory Materials of Aircraft Construction."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Mr. W. H. Dines, "The Heat Balance of the Atmosphere." 2. Mr. C. E. P. Brooks, "Continentality and Temperature."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. T. D. Lister, "The Tuberculosis Problem in War Time."

Oriental Studies, School of, London Institution, Finsbury-circus, E.C., 5 p.m. Miss A. Werner, "The Bantu Languages."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Mr. A. Yusuf Ali, "Modern Hindustani Drama."

Electrical Engineers, Institution of (Local Section), The University, Birmingham, 7 p.m. Discussion on "Fuel Economy."

(Yorkshire Section.) Philosophical Hall, Leeds, 7 p.m. Mr. J. Shepherd, "Some Points in Connection with Engineering Specifications."

THURSDAY, FEBRUARY 22...Geographical Society, Kensington Gore, W., 5 p.m. Mr. J. T. Jutson, "The Origin and Growth of the Dry Lakes in Western Australia."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. S. Prior, "Memorial Art in History." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. M. Emile Cammaerts, "Belgium as a Nation."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Mr. R. N. Sinclair, "Southampton Docks, Remodelling of an Old Dry Dock."

FRIDAY, FEBRUARY 23...Royal Institution, Albemarle-street, W., 5.30 p.m. Mr. H. Wickham Steed, "Some Guarantees of Liberty."

Economics and Political Science, London School of, Clare Market, W.C., 5 p.m. Mr E. F. Hitchcock, "The Importance of Imperial Wool."

University of London, University College, W.C. (Slade School), 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture VI.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, FEBRUARY 24...Royal Institution, Albemarle street, W., 3 p.m. Mr. D. Jones, "The Pronunciation of Languages in General." (Lecture I.)

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FRIDAY, FEBRUARY 23, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

TUESDAY, FEBRUARY 27th, at 4.30 p.m. (Colonial Section.) ALFRED BIGLAND, M.P., "The Empire's Assets and how to use them." W. A. S. HEWINS, M.P., will preside.

WEDNESDAY, FEBRUARY 28th, at 4.30 p.m. (Ordinary Meeting.) FRANCIS A. HOCKING, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs." ROBERT HUTCHISON, M.D., F.R.C.P., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COUNCIL.

At the last meeting of the Council, on Monday, the 19th inst., COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., was elected a member of the Council and Vice-President of the Society, in place of the late Duke of Norfolk, K.G., G.C.V.O.

CANTOR LECTURE.

On Monday afternoon, February 19th, PROFESSOR A. BERESFORD PITE, F.R.I.B.A., delivered the fourth and final lecture of his course on "Town Planning and Civic Architecture."

On the motion of the CHAIRMAN a vote of thanks was accorded to Professor Beresford Pite for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

HOWARD LECTURES.

The Howard Lectures on "Coal and its Economic Utilisation," by JOHN S. S. BRAME, Professor of Chemistry, Royal Naval College, Greenwich, have been reprinted from the *Journal*, and the pamphlet (price one shilling) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor and Howard Lectures, which have been published separately and are still on sale, can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 21st, 1917; LADY EMMOTT in the chair.

The following candidate was proposed for election as a Fellow of the Society:—

Willis, Henry S., Weardale House, Wearhead, Co. Durham;

and as an Honorary Corresponding Fellow:—

Belaiew, Colonel Nicholas T., C.B., Chemical Laboratory, Michael Artillery Academy, Petrograd, Russia.

The following candidates were balloted for and duly elected Fellows of the Society:—

Beaumont, Ivor, A.R.C.A., F.I.B.D., 74, Addison-way, Hampstead Garden Suburb, N.W.

Bebianno, Affonso, 858, Rua Barão de Mesquita, Rio de Janeiro, Brazil, South America.

Gaunt, Edgar Lawson, "Nethway," Horsforth, near Leeds.

Jones, George W., Gough-square, E.C.

Mervyn-Howell, William, 13, Cathedral-road, Cardiff; and 3, Essex-court, Temple, E.C.

Starr, David Alfred, Clyde Valley Electrical Power Company, 53, Bothwell-street, Glasgow.

THE CHAIRMAN, in introducing the reader of the paper, said there was no one who had a greater knowledge of the conditions of clerical work, of what was necessary in the way of training, of how that training should be undertaken, and the right posts that women and girls should occupy after they had been trained, than Mrs. Hoster. Since

the outbreak of the war great changes had naturally come about, and the present condition of things was a somewhat unsettled one. The spirit of the response made by the women of the country had been splendid; but at the same time many women regretfully felt it had shown there was a large amount of latent ability that was untrained. At the present moment there was a vast number of girls who had taken employments of different kinds for which they had no sort of training, and she thought the Government was the biggest sinner in this respect; they had entirely gone in for quantity without any idea of quality. Many women felt that the wages offered for some of the work were far too high, while for the more skilled work they were far too low. She looked upon the thorough training given by the author as a remedial measure for any future work undertaken in an amateurish spirit. It was extraordinarily difficult to know what would happen when the reconstruction came after the war. All the women who had been doing a certain amount of work during the war would not care to remain at home in the future; they had, for the first time, got a taste for work, but they would be launched out, not as substitutes for men, but in competition with men. That was the great difficulty and the great danger. She knew it was not a very popular subject at the moment to say that women should not be undertaking work when they were not trained for it, for the simple reason that women were so keen to do something. It was because she was so anxious that the views which Mrs. Hoster held should become known to big employers of labour, and above all that her views should be instilled into some of the Government officials who had the ordering of things, that she had such great pleasure in accepting the invitation to preside over the meeting.

The paper read was—

THE TRAINING OF EDUCATED WOMEN FOR SECRETARIAL AND COMMERCIAL WORK, AND THEIR PERMANENT EMPLOYMENT.

By Mrs. Constance Hoster,

Hon. Secretary of the Society for Promoting the Employment of Women.

I have been asked to speak to you on the training of educated women for secretarial and commercial work and their permanent employment, and I would like to preface my words by saying that I fully realise that at the moment *training* is not a popular subject; but the one way for women—especially educated women, with whom I am more particularly dealing—to find a permanent place in the world of work is by *training*.

The Society for Promoting the Employment of Women, of which I am honorary secretary, has worked for fifty-seven years to prevent the overburdening of the labour market with unemployable — because untrained, or only partially trained—women.

When this Society started it had to instruct the public in the fact, not only that many women were already self-supporting, but that the majority of those who were so were supporting themselves under very adverse conditions for lack of a suitable training.

The old opinion that women are necessarily provided for by their men relations, though still often quoted, cannot, I think, be honestly believed by many people in these days; but it is astonishing to find how few have grasped the idea that since woman has to compete for her livelihood in the open market it is grossly unfair to allow her to do so without the equipment that public opinion takes it for granted will be supplied to her brother.

I quite realise that these are, of necessity, days when most of us find it easier to live in the present, and not to look to the future for fear of what it may hold for us. And surely this is not to be wondered at, for to go on from day to day, looking neither before nor after, is the only way in which many are able to live at all.

But this is not sufficient: more is asked of us, and more is expected. We *must* look to the future, not for our own sakes, but for the sake of others—of those who are to come after us, and, above all, for the sake of our country, her interests and her welfare. While her men are fighting in her defence, surely it is not too much to ask of her women that they should give thought to the future. As Herbert Spencer says: "To fit us for complete living is the function which education has to discharge."

I have this subject very much at heart, and I must again and again urge the necessity for *thorough and complete training* for our young people, so that they may not only be in a position to undertake successfully the branch of work for which they are best fitted, but also that they may be able to raise and maintain the standard of pay for competent work.

One of the results of the war will be that many will have to earn who hitherto have not been obliged to do so, and it is to those especially that I appeal to-day.

The only really successful worker is the worker who has been trained and who has made herself efficient in her own special branch. Anyone who considers the question at all must realise that after the war the labour market will be flooded with half-trained workers who

will be a danger to themselves and to those who are highly efficient and trained. Therefore it is easily understood that the greater the number of these highly-efficient and trained workers, the greater their power to uphold the highest standards of work and pay, which otherwise the half-trained, by sheer force of numbers, would tend to lower.

The country at all times requires our very best, and though it has been compelled in this crisis to accept in many cases the services of the untrained, people are beginning to see that this is not as it should be, and that there is no reason why it should continue. Only a day or two ago I read these words:—

"There is not the smallest doubt that in all Government Departments money is being wasted on salaries paid to incompetent girl typists. It is not the girls' fault in many cases. Demands were made for large numbers to come forward, and it was stated that previous experience was unnecessary. As a result hundreds of girl milliners, dressmakers, shop assistants, and the like, offered their services and were accepted. They have done their best certainly, but without the necessary training and education it is impossible for them to attain the level of the woman with years of study and experience behind her.

"A woman holding a responsible position in one Ministry gave her opinion that the work of her special department could be just as well carried out by half the number of secretaries employed at present, provided trained workers could be substituted for the untrained or partially-trained girls now employed."

Our young people should be persuaded therefore to consider that the best course to follow is to equip themselves *now* for the needs of the future and to avoid short emergency trainings as against national interest. Yet how difficult it is to think of training now when everyone is being implored to give her services trained or untrained. But training *is* just what is needed to make women's work permanent after the war.

To look at the matter from another point of view, the services of the trained will not be dispensed with even after our soldiers and sailors return. There is bound, unfortunately, to be a shortage of men, and the efficient women will be kept to work side by side with the men whose places they have helped to fill in a time of stress.

It must also be remembered that many of those who, feeling that they would like to do "something to help," offered themselves for clerkships, etc., will not, even if they could afford to do so after the war is over, be content to remain at home again more or less idle.

Yet it requires little imagination to realise that hundreds of these will be the first to be thrown out. Therefore they cannot be too strongly urged to have definite training now for whatever profession they wish to enter, instead of waiting till the war is over. Quoting from a writer to the *Evening News* of January 8th:—

"The trouble is that the girls who in the ordinary course would have been training last year have gone into the War Office and other offices without training. Of course, they will never get more than 25*s.* a week, and, after the war, they will all be out of work.

"Some of the training schools are even sending typists out half trained. Girls came from one of them to do some work for me, and they did not know what carbon paper was! And the wage they were asking was 25*s.* to 30*s.*"

Then, again, take the position of the quite untrained at present receiving small salaries which do not constitute a living wage, but which, after all, are a fair equivalent for the work done. They have little idea of the routine of an office—or, indeed, of office methods and organisation—and, however good their intentions, they must come short of much that makes a really good worker.

I do not wish to imply that we do not owe a great debt of gratitude to those who have so whole-heartedly thrown themselves into the breach and have helped at a time when their help was most needed, but I do desire to point out the danger in the future if "thorough training" is not now taken as our motto.

Perhaps you will allow me to tell you why your Secretary has suggested that I should be the one to give an address on this subject. For over twenty-four years I have been in the midst of women's work, and have come into contact with it from an absolutely practical point of view. In addition to training for all secretarial positions at my offices, I have a registry which was first started for my pupils, but as I have always wished to take only a limited number of these I found that I had many more posts at my disposal than applicants to fill them, and therefore instituted the free registry for the benefit of gentlewomen seeking secretarial employment.

Since the war I have found 2,378 posts for applicants to the registry, classified as follows:—

Permanent	1,121
Temporary during War . . .	571
Temporary	686

I give these figures to show that my experience has been fairly wide, and I would mention just a few of the positions obtained by those who have passed through the registry. There are,

of course, many grades of work—(1) the highly-trained organising secretary, (2) the private secretary, (3) secretaries to heads of big merchants' offices, bankers, etc., (4) the more ordinary shorthand typist in commercial offices, (5) the accountant capable of supervising a department, (6) the book-keeper working under the accountant, (7) the indexer, (8) the tracer, and also the posts for (9) the vast army of clerical workers—by which I mean those who are only doing handwriting, either in connection with insurance work or the War Loan, or work of a similar nature.

Let me give you a few instances. In the very early stages of the war many new spheres of work were necessarily opened to women, both in the commercial world and in many Government Departments. So much extra secretarial help was required by hospitals, war societies, and other new organisations. I was able to introduce the first woman to be admitted into one of the largest insurance offices in the City at a commencing salary of £150. Now she is at the head of a department of sixty-two girls and women—shorthand-typists, clerks, and book-keepers, and I am told by one of the directors that they consider the lady who had been put in charge is simply "doing wonders," and that in every department of this huge firm the women and girls have won golden opinions. One society—and I may add a woman's society—which is doing public work in connection with the agricultural question, started with an organiser at a salary of £300 a year. The Government offices, too, in spite of much criticism as to salaries, have applied to me for workers to fill really responsible positions, and have offered salaries varying from £2 10*s*. to £4 a week; and one applicant, with exceptionally good languages, is now receiving £5 a week. More than ever before have I been asked to supply secretaries to go abroad, and have filled positions in Madeira, Madrid, Alexandria, Copenhagen, Valparaiso, The Hague, Russia, Sweden, Berne, and Aden, and in each case the salaries have been good.

Naturally many of the students have passed on from their first positions to more responsible and remunerative ones, showing the value of experience added to training. One is now the secretary of one of the largest of our hospital organisations; another is engaged on very confidential war work at a salary of £156 a year; another pupil, who started in a position at the War Office, has now been transferred to a special department, and is receiving a salary of £4 a week. I might add that I was asked to release my own private secretary at a day's notice for work in the Prime Minister's "Garden Suburb."

I might also quote from some of the letters I have had giving details of the different positions held by educated women, and showing how much their work is appreciated.

One says:—

"To-day I have been promoted to a position which has never been held by a woman before. The Chief of the Section sent for me, thanked me for getting out the balance correctly, and told me that my work was 'better than most women's, and as good as many men's.' This, I am told, is great praise from him."

Another says:—

"I was at a House of Lords Appeal to-day reporting."

And a third:—

"I know that you take an interest in old 'trainers,' and so I am writing to tell you that I left my post as private secretary to Lord G—— at the end of October to take up work as a company secretary. I have now been there a month and like the work very much, although I have got a lot to learn, and have to spend all my free time reading up about company procedure, etc.

"I get £192, free of tax, which I suppose amounts to about £215, and I have very nice hours, 10 to 5.30, and on Saturdays till 12. I have a nice office all to myself, and all my filing and copying of letters is done for me. I am really taking the place of two men, and am quite a proper *dilutée*. I attend the Board meetings of all the companies, and read the minutes, etc., and I keep the entire accounts of one company."

I think, perhaps, what would interest you most now would be to trace the history of women's work, especially in this branch, since the beginning of the war. I am sure everybody connected with women's work will remember how thousands of workers were thrown out of their positions in, I may almost say, an hysterical fashion by their employers, and we were faced with the grave difficulty of finding fresh openings for those thus dismissed. Even in that crisis I felt quite sure that the thoroughly trained would soon be able to return to their own profession with, if possible, better salaries—and happily in this I was right. I would again point out that the lesser trained or half-trained were the last to find positions.

I am only emphasising this fact to prove the necessity and wisdom of training, and to show you of how much greater value the trained worker can be to her country than the untrained.

I think you would all feel this, too, had you,

as I have, come into contact with the sad cases of elderly educated but untrained women, and been so intimately connected with the special conference which was called to discuss and formulate schemes for their benefit. The report lately issued on this subject should serve as a warning to the present generation.

Then came the next stage—a demand for women to take the place of men going to the Front, and there was an epidemic of short trainings of all kinds. The most immediate need was to help to fill the places of those who had joined the Forces, and so carry on without a break the work they had been doing and had, perforce, to leave; and every nerve was strained to find women and girls ready and willing to offer their services. Short trainings were arranged, which have undoubtedly been of some value, though their *permanent* benefit to the world of commerce is questionable.

Amongst the many schemes at that moment there was one which has really been helpful, especially to the banks, *i.e.* the short training in banking work given under the auspices of the Society for Promoting the Employment of Women, to enable those with special aptitude for figures to step into the breach caused by those called to the Front. Those who had the training were able to show that the rumours that the girls and women who flooded the banks were unsatisfactory arose from the haphazard methods of selection, which seemed to be based on the view that, as women had not worked in banks before, they must all be equally useless, and consequently no attempt should be made to sort the suitable from the unsuitable—the able from the helpless. When the weeding-out process began, it naturally took some time. In this connection, I would quote from a letter from one of our leading banks:—

"Should National Service be introduced many vacancies for ladies will certainly occur, and probably it would be wise to continue the classes for a little while longer, as your pupils, I am sure, will be in strong demand if compulsion is adopted."

As I was anxious to know how many women were now being employed altogether in our leading London banks, I approached the managers and, through their courtesy, received the following statistics. Of course, I cannot mention any names, but the numbers are as follows:—

In A . . .	1,612	Engaged since the outbreak of war, with the exception of perhaps 6.
In B . . .	1,110	Only since the outbreak of war.
,, C . . .	986	Ditto.
,, D . . .	740	Ditto.
,, E . . .	550	50 before the war, 150 now engaged permanently, 400 only since the outbreak of war.
,, F and G .	14	Only since the outbreak of war.
,, H . . .	6	3 only since the outbreak of war, and 3 before that time.
,, I . . .	4	Only since the outbreak of war.

I might also add the following comparison taken from an article in the *Times* of the 6th of this month, which shows that in banking and finance 9,500 women were employed in July, 1914, as against 37,000 replacements by October, 1916.

I must here pause and dwell for a moment on the need for efficiency, which training as a groundwork alone can give. After the war it will be even greater, because it will be a question of the survival of the fittest, and it is only the "fit" who can hope to raise and uphold the standard of work. Therefore, because of the *future* as well as of the *present*, we must urge the necessity of careful training, which alone can make work really valuable.

In my work, which is by no means confined to the secretarial profession, I naturally come into contact with many different degrees of *efficiency* and *inefficiency*. What seems to me the greatest drawback to attaining *efficiency* is the desire for, or perhaps it may even be the necessity of, earning long before the would-be earner is at all ready for her work. Technical subjects are so often started before the general education is completed, and though—and this applies more especially to secretarial training—greater mechanical speed may result from beginning very young, yet this is but a surface efficiency, and does not stand the test of time.

If we wish women's work to have the firm footing it deserves, we must, one and all, fight the growing tendency to snatch at any opening in order to help in the present crisis. We have to look to the future, and we shall help our country just as much, if not more, if we are able to persuade those who can give up time and money to work steadily at whatever profession they wish to enter before joining the ranks of the wage-earners. It is by *efficiency* that we can hope to prove our value in the world of work.

I think the parents still need educating and imploring not to allow the advantages of the immediate present to weigh against the far greater advantages which await the efficient worker in the future. They must remember that a smattering of either education or technical training is of little value.

As regards the actual training for the profession we are discussing, I endeavour to make my pupils self-reliant from the beginning, and to look upon their "training" as part of their life's work; I try to inculcate the idea of loyalty to their future employer; in fact, the head of the Pupils' Department is looked upon almost as an employer, for all work passes through her hands from the very commencement of the training. In this way the pupils are taught to regard their work as "real work," and to be careful, accurate and neat, and never to think "anything will do." I find that this answers splendidly, for it teaches them to become very critical both in regard to their own efforts and the work of others.

I also emphasise the necessity for adding to the curriculum the technical study of foreign languages, and, if possible, their shorthands—in this respect we, as a nation, do not shine. Book-keeping, too, is a very useful and necessary subject, not only for itself and for the use it may be put to either commercially or in the home, but also as an excellent mental training in method and quickness.

Another point in the training is that as soon as pupils attain to any speed in shorthand I expect them to rely upon themselves entirely and to set about their transcripts—*i.e.* the transposing of their shorthand notes to the machine—in a prompt and businesslike way. I also train them to keep their papers tidy in a very small space, and to arrange their work methodically.

Further, I do not approve of large classes for the initial stages, three or four being a good number, but to have some competition is wise; it is also necessary to show judgment in the selection of those who work together, for it does not do to have a very quick learner with a slow one, who, however, in the long run may do just as well if not disheartened.

I could speak in much greater detail about this part of the training, but I do not think such technicalities would be interesting to my hearers, so I have only given a broad outline of what I have found to be a good system for those entering upon their professional career.

"The future depends on the present," as Professor Gilbert Murray said in a delightful address given to young girls, and a great future lies before the younger generation. It is our duty, therefore—the duty of the older ones—to give the young full scope to develop their powers and their talents, not only for their own good, but, above all, for the good of their country.

It is then absolutely essential that all would-be workers should set themselves a high ideal of efficiency and not be content with mediocrity, for how can an employee expect consideration from an employer for indifferent work?

Hitherto we have had to fight against underpayment of workers; at the present day a new danger has arisen, that of the overpayment of *unqualified workers*, who are encouraged to set a false value on themselves and are bound later on to suffer when this crisis through which we are living is over.

In conclusion, I would again ask all who wish to rank among the workers of our day to think over well the work to which they feel most attracted, and then to take absolutely the best trainings available to fit themselves for the careers they have chosen.

I know we have the reputation of taking a long time to wake up, but, as I was told the other day, when we do wake up, it takes a tornado to stop our rush. May this apply to the influx of demands for training!

DISCUSSION.

SIR ROBERT A. HADFIELD, F.R.S., in opening the discussion, said the subject with which the paper dealt was one that appealed very intimately to a busy man like himself. No one suffered more than a busy man from the incompetence of his shorthand writer. Almost without exception the applicants for shorthand positions were not sufficiently trained, and there was plenty of room for ladies who would make themselves competent in the art. Competency, in his opinion, meant the ability to take down shorthand correctly at 150 to 160 words a minute. He could write shorthand himself at about 80 to 100 words a minute, and he drafted out a good many of his proofs in shorthand, but that speed was of no use to an extremely busy man for dictation purposes. He urged on the author the desirability of impressing on her pupils the necessity of getting up a high speed. It was just as noble to be a good shorthand writer, and to help busy people to do their work, as it was to do many other things which appeared to be of higher value. He was afraid also that people in England had a prejudice against a typewritten letter, and he hoped one of the results of the paper would lead to a better understanding on that point. A few years ago

it was considered rather an insult for a person to receive a typewritten letter on a personal matter; but he himself would much rather receive a typewritten letter than a badly written one, because it was impossible to read the latter. America was not so prejudiced in that respect, and he believed the President of the United States personally used a typewriter for his correspondence. The author had not referred to one subject which was almost as important as that of shorthand and typewriting—namely, the art of making a correct *précis*. That was an invaluable help to a busy man. Every morning he received a large number of special letters, statements and reports, which he had not time to go through in detail, and it was simply invaluable to have a good secretary who could grasp the ideas in them and briefly put them into *précis* form. Women who could do that class of work would be able to command much higher rates of salary. Personally he was only too pleased to pay the highest rate of wage to competent people, but it was very annoying when he did so not to get the service expected. It led to bad temper on the part of everyone concerned, which was not at all dignified, but the poor shorthand writer and typist had to get used to it. The better service she rendered, however, the less disturbance of temper on both sides would result.

THE CHAIRMAN (Lady Emmott) said that although notices had appeared in the press in connection with the National Service that applications were not yet to be made for employment, certain people had applied, whom she had seen at Mrs. Tennant's request, and she had been distressed at the number of people who were very keen and anxious to do something for the country and who, when asked what they could do, said, "I will do anything." There was nothing so fatal as that, because one knew at once that the applicant must be inefficient. It would be very much easier if people knew definitely what they could do.

MR. J. QUINN inquired if the author had ever thought of any way in which she could bring home to the powers that be in the elementary educational world how they could qualify, in ordinary educational matters, the young people that intended to take up secretarial work. For the last quarter of a century he had had a good deal to do with the training of the young, and the great conundrum with which he had been faced was the lack of fundamental elementary education on the part of students. Sir Robert Hadfield had asked for shorthand writers who could write 150 or 160 words a minute, but it would take five years for 75 per cent. at least of the young people who took up the system of secretarial training to do so in view of the amount of general education that they possessed, and at the same time to develop their all-round abilities. He desired to emphasise the necessity first and foremost of a proper training in the English language. If a student thoroughly understood her mother tongue, could speak it and spell it, and define it correctly, that, combined with a fair store of general knowledge, was infinitely better as a preliminary training than any amount of speed practice in shorthand. Those responsible for the education of the young should, in his opinion, devote much more attention to grammar, composition, spelling, and *précis* writing. Out of 20,000 students that he had trained not 1,000 were fit to go right on to their subsequent training without constant attention to simple elementary English. If the training were carried out in the way he had suggested, he thought it would be much more effective and much shorter.

MRS. HOSTER, in reply to questions asked by two ladies in the audience, said she did not as a rule take any girl under eighteen years of age to train for commercial work; but since the outbreak of the war she had taken a few of seventeen. The lowest standard she would admit into the office was a high school education, but unfortunately that was not always a very high standard. She always impressed upon the more highly educated girls that it was more necessary for them to be technically competent, otherwise they would lower the standard of women's work. The less educated girls might type more quickly, but they would not win in the long run because their speed alone would not help them; but there was a tendency, especially among some of the college girls, to think that education would carry them through without technical speed and accuracy. She impressed upon her pupils the necessity of being accurate first and attaining high speed afterwards, because it was impossible to attain to the high speeds without a thorough groundwork. Mr. Quinn had to take pupils who could not have the same knowledge and insight into work and help their employers as those who had had a proper education. Nevertheless, Mr. Quinn had achieved wonders, considering the material at his disposal. Then she had been asked how long it would take a student to get up to a speed of 150 or 160 words a minute. That was absolutely a matter for the student herself. She expected a student to attain a speed of at least 100 words a minute in six months; a good many went up to 120 and 130 in that time, but that was exceptional; and there was no reason why at the end of nine months or a year of practical work the student should not do 150 or 160 words a minute. It was no good attempting the high speeds until the lower speeds were absolutely accurate, not only on easy matter but on any matter. The uneducated could not be expected to be accurate in taking down a Parliamentary speech or a speech on any technical subject, because they did not know the language that was being used. They got down the sound in their notes, but the transcripts were simply hopeless. Education was

really the foundation for a good worker in the profession, and it was more and more necessary as time went on. Then she had been asked whether the salaries of the women who took the places of the men were the same. Where they did equal work they received equal pay, but it was unreasonable to expect that girls who had just gone into the banks should receive the same pay as men who had been doing the work for years. She had been told that in a good many cases the girls had started at a much higher salary than the men had, because they were looked upon as temporary workers. In some of the banks one trained man was probably doing the work of three untrained girls, and the same salary would not be paid to them. The banks had been very fair about the salaries. In reply to another question, it was impossible to expect girls at the age of thirteen to have imbibed all the knowledge that was necessary for higher branches of the work. There were, of course, brilliant exceptions; but the mass ended by being just ordinary shorthand typists, for whom it was a great pity there was such a large demand. She wished employers, and the Government especially, would realise that it was far cheaper to pay £2 10s. a week to two competent typists than £1 or £1 5s. a week to six that were incompetent.

SIR HENRY TRUEMAN WOOD thought it was a pity that the discussion had drifted into a consideration of shorthand and typewriting only. If women were to do good work in the world on the special lines indicated by the author, he hoped it would be of a more responsible character. It was a well-known fact that when young men became skilful shorthand writers and typists they were so valuable to their employers that often they would not allow them to pass on to more important work, and the same thing would happen to women. What was really required, whether in a man or a woman, was a well-educated individual who could take up any work to which he had to put his hand. If he wanted a man for responsible and difficult work he would sooner choose a university man from Oxford or Cambridge who had had his mind trained so that he was capable of turning it to any particular business, of which he would very soon learn the routine; and for ordinary commercial work he would much sooner have a young man who was well educated and fairly capable than an ill-educated boy who had been to one of the shorthand-typewriting schools and taught to take down badly in shorthand. For the last few years the increase in the number of girl students at the Society's examinations had been marvellous, and the increase in the quality of their work was equally extraordinary. The number of women who took prizes at the examinations, which was a very good test of ability, was also very considerable. When peace came the question of the survival of the fittest would arise in connection with women, as it had done with men. If they were proficient for the positions they at present occupied they would continue to hold them; if not, they would have to give them up.

MRS. HOSTER said she had desired all through her paper to emphasise the necessity of education first. Shorthand and typewriting came second. Shorthand was a means to an end; it was not the end itself. All the higher posts to which she had referred were not occupied by shorthand typists. High shorthand speed in connection with education was of course invaluable, but it was not everything. Sir Henry had stated that once a young man became a good shorthand typist he did not rise to anything else, but that was not the case with girls, because they had more initiative than the boys. She advised her students to take their first post for experience, and either they would rise in the office or they must leave and obtain a better position in a wider sphere, so that they could use their education, their training, and their experience.

MR. JAMES STEPHENSON considered that shorthand and typewriting should be regarded merely as routine subjects. The object of shorthand was to save time, but commercial education ought to be looked at in a much broader way. He viewed commercial education from the point of view of an engineer and regarded a business undertaking as a machine. It was necessary first of all to know everything inside the business concern, such as book-keeping, commercial correspondence, and office organisation. Then it was necessary to look outside the concern, and study commercial law and subjects which gave vision to those in charge. It was impossible for this country to extend its trade and become the greatest commercial nation in the world without vision, and that would never come from shorthand and typewriting. It could only be obtained by studying what our competitors were doing, and that involved the acquisition of foreign languages, which he regarded as a most important qualification. He also advocated an alteration of the present matriculation examination, in which the compulsory subjects were, firstly, English; secondly, a good knowledge of mathematics; and, thirdly, a science or an ancient language. Was it not feasible that the syllabus should be altered so that it was possible for a student to take science, an ancient language or a modern language? In that way the universities would be encouraging the study of foreign languages, and would place commerce upon the same basis as arts and science.

MRS. NATHANIEL L. COHEN hoped that, as the education of the country was about to be revolutionised, the new Minister of Education would be urged that such a system should be adopted that the minds of the people would be so trained as to make them powerful and elastic, so that they could always cope with the unexpected that was always turning up.

MISS MARGARET FRODSHAM pointed out that, as the author received only girls who had had a high school education, she had had the advantage of dealing with pupils who had already had trained teachers to teach them. The elementary education of the country was at present in such a condition that large numbers of governing bodies continued to appoint elementary teachers who fulfilled the statutory regulation that they had reached the age of fourteen and had been vaccinated.

MR. G. F. PITTAR thought that in a great many cases much time would be saved if commercial men dictated their correspondence straight to the typewriter, without the use of shorthand. He had personally found that of the greatest assistance, much time being saved in correcting the manuscript, while the principal had not to wait to sign his correspondence. Before the war he was acquainted with an office in which there were a certain number of both women and men typists, and the principals preferred to dictate to the latter rather than to the former because if they met with any difficulty they came and asked about it, whereas the lady tr anscribed what she had on her notes, whether it was sense or not.

MRS. HOSTER agreed with the last speaker that it was invaluable there should be in every office one or two typists who could quickly rattle off a letter that was dictated to them straight on to the machine without making any mistakes.

On the motion of the CHAIRMAN, a vote of thanks was accorded to Mrs. Hoster for her pap er, and the meeting terminated.

DRAWN-WORK INDUSTRY OF SWATOW.

While the export trade from Swatow in drawn work had begun to decline before the outbreak of hostilities in Europe, the war has seriously affected the local industry, as European countries were Swatow's best customer for drawn work, and it is but natural that the demand therefor (such goods being in the nature of a luxury) should fall off sharply in the belligerent countries. Recently, however, the industry has showed signs of recovering.

As the term signifies, drawn-thread work is openwork done on grass or other cloths by drawing out threads or by cutting holes in the cloth, and then working the open spaces with cotton thread into floral or other designs. The manufacture of drawn work was first taught to native women in the Swatow district by missionaries some twenty-five years ago, and the industry has flourished ever since. It is believed that the patterns and designs came originally from Europe and Mexico.

In the beginning the output was insignificant and the wages small, each female worker earning about 5*d*. a day. Gradually more women took up the work, new patterns were introduced, and the skill of the workers became greater, some of them earning as much as 1*s*. per day. The work was first done in Swatow, but as it was such that it could be done in the homes women in the interior took it up. Naturally, the output increased and competition followed, with the result that the workers' wages fell. A first-class worker now receives only 6*s*. to 10*s*. per month. The work is at present carried on chiefly in the neighbourhood of Swatow and in the Kityang district.

According to a report by the United States Consul at Swatow, the grass cloth that is used locally for drawn work is made from ramie grown in the Yangtse River valley. There are two kinds, the finer of which is produced in Hsin Huei and exported from Canton, and the coarser quality is manufactured in Kityang. The Canton cloth is woven on foreign looms, and comes in bolts of 32 in. by 20 yards or 16 in. by 40 yards. The Kityang cloth is made on Chinese looms; the bolts measure 15 in. to 22 in. by 20 yards. The cotton thread used in working up the designs is foreign spool thread (chiefly British) and crochet thread in balls.

Most of the drawn work exported is embroidered. Embroidery is an old native industry, but the methods now in use are modern. This work is done exclusively at Chaochowfu, a large city about twenty-five miles from Swatow. The thread used is either plain or mercerised cotton. The natives engaged in embroidering receive very scant wages—1¼*d*. to 2½*d*. a day. The annual value of the exports of drawn work from Swatow is estimated by dealers at over £10,000.

INDIAN LEMON-GRASS OIL.

The chief commercial centre for lemon-grass oil is said to be Trivandrum, Travancore, and the exports are made from Cochin and Quilon. The shipments to all countries in the fiscal year ended March 31st, 1916, were 30,976 gallons (value £37,200), an increase of 3,561 gallons over 1914–15. Exports to the United States in the half-year ended June 30th, 1916, were 37,883 lb., valued at £3,800, and in the calendar year 1915 they were 88,480 lb., valued at £9,700. The price in Cochin at the end of June was 30*s*. per dozen 24-oz. bottles.

Obscurity prevails as to the botanical sources of East Indian lemon-grass oils, but they are generally stated to be derived from *Cymbopogon citratus* and *Cymbopogon flexuosus*. According to a report by the United States Consul at Madras, the former is a native of Bengal and is largely cultivated all over India, but the oil distilled in the Malabar coast is derived principally from

C. flexuosus. This plant grows plentifully in Travancore, especially on the slopes of the mountains to the north of Anjengo. The hill-sides are said to be fired in January to burn down the old and useless grass. Six months later the fresh crop is ready to be cut; by that time the countryside is dotted all over with furnaces and stills. During July, August, September, and October operations are continually maintained, but there would appear to be no second crop. In a few cases Europeans have established distilleries on an improved plan.

The moplas (native gatherers) are said to recognise twenty-seven forms of the wild plant, of which five only are of commercial value and one is cultivated and never flowers. The most interesting feature of lemon-grass oil is the large percentage of citral that it contains. This has been variously stated at 70 to 80 per cent., and inferior or adulterated samples 40 to 50 per cent. It is employed in the manufacture of artificial perfumes, such as the violet, known as ionone, and like all the grass oils is utilised mainly in perfuming soaps. An important use to which it is applied is in the preparation of furniture polish. The production of lemon-grass oil in South India on a commercial scale is an industry of comparatively recent growth.

ENGINEERING NOTES.

Hydro-electric Power in the Commonwealth and in New Zealand.—The Minister for Public Works has referred to the Public Works Committee of New South Wales the adoption of the following schemes for the utilisation of electric power on the Murrumbidgee River, at Barren Jack Dam and at the Snowy River. In constructing these particular dams provision had to be made to allow for a continuous outflow over the dams, and engineers considered this wasted power could be economically harnessed for generating electrical power. The estimated cost of the second scheme, outlined in the report, would amount to £100,000 for providing the construction of plant, transmission lines, and distributing houses. The power generated would approximate 8,000,000 units per annum. The Minister indicated that the annual expenditure on such a scheme would amount to £9,095, and the revenue £11,686, leaving a net profit of £2,591. This might not be the immediate result, but was an estimate for a few years after the scheme was in operation. The proposal related to the requirements of towns on the south-west tableland—Goulburn, Yass, Harden, Cootamundra, Junee, Wagga, Gundagai, and Tumut. The second scheme was that of works on Snowy River. The Minister, Mr. Cann, said this was far more costly and pretentious than the Barren Jack scheme, and had infinitely greater possibilities, but settlement had not yet taken place, and the power generated would have to be distributed over a much greater distance. The proposed dam on the Snowy River, about a mile below Jindabyne, would be 148 ft. high, and would have a capacity for 26,000,000 cubic feet of water. The power-house would develop an average load of 100,000 kilowatts, with a maximum of 125,000, and there would be available at the point of delivery 750,000,000 units of electricity per annum, as compared with 8,000,000 in the Murrumbidgee scheme. The transmission line for the power-station would be 210 miles in length, and would bring the power right into Sydney. It was anticipated, however, that a large amount of power would be used on the south coast for electro-metallurgical and other processes. This would enable New South Wales, better than any other State, to compete with electric process manufactures in the old world, such as the treatment of ores, etc. The estimated capital cost was £5,000,000. The annual cost, including interest, etc., would be £361,173, equivalent to £2 3*s.* 5*d.* per h.p. per annum; and if all the units were sold at ½*d.* per unit the éstimated surplus would be £37,777. Mr. Cann outlined schemes of a like nature in regard to hydro-electric development on the Shoalhaven River, Cataract, and Cordeaux Rivers, Gilmore Creek and the Tumut River. These were all referred to the Public Works Committee. As to the daughter State of Tasmania, the *British Australasian* says, in view of the increased demands which it is expected will be made by metallurgical undertakings upon the Government Hydro-Electrical Department for power, it is understood that steps are being taken to obtain data respecting Lake St. Clair, situated some twenty-five miles westerly from the Great Lake (*see* "Engineering Notes" of July 28th, 1916). Lake St. Clair, it is stated, has a surface area of about thirty miles, and varies in depth to 600 ft. If anticipations are realised, a fall of approximately 1,000 ft. will be obtainable when this supply is harnessed. The general programme of the Tasmanian Government in connection with hydro-electrical power for industrial purposes has been outlined in a Ministerial statement already published. Unofficial estimates have been made giving the present nominal capacity of the existing works at the Great Lake as equal to some 10,000 h.p., and the approximate total which may ultimately be developed as up to 100,000 h.p. With reference to New Zealand, Mr. J. Orchiston, M.Inst.C.E., Chief Engineer of Telegraphs, New Zealand, in a letter to the *Times*, points out that the South Island of New Zealand is richly endowed with magnificent water powers, many of them coming right down to the water's edge in the sounds on the south-west coast. Water powers ranging up to 40,000 h.p. can be obtained at an expenditure of from £5 to £10 per h.p. for the hydraulic

development, and in many cases no transmission lines would be needed, as the power-station could be located alongside deep water. Heads ranging from 500 ft. to 1,000 ft. or over are procurable, so that the conduits, piping, water-wheels, foundations, etc., need be only of minimum dimensions for the output developed. In some cases less than a mile of piping is all that would be required to utilise a head of 1,000 ft., with a constant flow ranging up to 500 cubic feet per second, fed from glaciers. By the construction of a tunnel about five miles in length, mostly through granite, the whole of the discharge of the Te Anau Lake, covering an area of 135 square miles, could be diverted to one of these sounds, giving an effective head of nearly 600 ft., and a constant discharge exceeding 12,500 cubic feet per second. Few countries can so easily provide a power of such dimensions (approximately 700,000 h.p.) at the edge of a deep-water harbour. There are numerous other water powers available inland, ranging up to 100,000 h.p., which could be developed at a very low cost, but they are at present not conveniently located for transport purposes, and they would involve fairly long transmission lines.

Heating Dwelling-houses.—A writer in the New York *Electrical World*, who has been carrying out experiments in the heating of dwelling-houses by means of coal and electricity, has come to the conclusion that, with electricity at $\frac{1}{4}d.$ per kilowatt-hour, it is from 25 to 50 per cent. more expensive than for coal at 25*s.* per ton. At $\frac{1}{2}d.$ per kilowatt-hour, electricity is two and one half or three times as costly. These figures are borne out by theory, which indicates that the 10,000 B.Th.U. in a pound of coal cost $\frac{1}{12}d.$, while in the form electrical energy the 3,413 B.Th.U. in 1 kilowatt-hour will cost $\frac{1}{4}d.$, making the current roughly five times as expensive; then allowing for a furnace efficiency of 40 per cent., which is fair for the ordinary furnace, the current should prove twice as expensive. A hot-water radiator system was employed in both cases. Some interesting figures, also on the same subject, were given recently, in a paper by Mr. W. B. Smith read before the Greenock Electrical Society. The author said that in actual heating value electricity is seriously handicapped when compared with coal and gas. From each unit of electrical energy only 3,410 B.Th.U. can be produced, so that at $\frac{3}{4}d.$ per unit, one pennyworth of electricity gives 4,550 B.Th.U. One pennyworth of gas at $2\frac{5}{11}d.$ per 1,000 cubic feet has a heat value of about four times this amount; while for coal at 25*s.* per ton the same cost would yield 105,000 heat units, or over twenty times the number of B.Th.U. But the excellent efficiency of electricity for heating enables it to compete in point of cost with gas at least, and, although more costly than heating by coal fire, its other advantages would certainly recommend it in preference to the coal fire.

CORRESPONDENCE.

THE BEN-I-ISRAEL.

In connection with the paper of Sir Thomas Holdich, I am somewhat surprised to note that he is inclined to recognise the Armenians as some of the lost tribes of Israel and of strong Hebraic appearance.

Is it not agreed that the Armenians were of Phrygian descent (in other words, Iranians), and had advanced far east by the middle of the fifth century B.C.?

As far as concerns those in the districts of Aleppo, Carchemish and Haran, or South-Western Armenia, there would probably be many descendants of the old Hittites, who are said to have had a Mongolian origin, and indeed in the old monuments are represented as wearing pigtails. I have seen somewhere a profile of a Hittite wife of an Egyptian Pharaoh which strongly resembles the women of this region. The children there often are like young Italians. The hair of the inhabitants is frizzy and dark (not black), very unlike their neighbours the Syrians. They have fine large eyes, mostly brown or hazel, and clearly marked eyebrows and long eyelashes, while the nose is not hooked but has a prominent bump in the middle.

Although in customs they strongly resemble the Jews and Mohammedans, and indeed freely do business with the former, and even enter into partnership with them, yet they avoid social intercourse as far as possible, and are very strongly opposed to marriage with them.

About what time are they supposed to have adopted the typical ending of "ian" to their names? I have never come across it in Armenian names in the history of old Egypt.

HYLTON B. DALE.

Radleigh,
Village Road, Enfield.

OBITUARY.

HERBERT OAKEY.—Mr. Herbert Oakey, whose death took place on November 13th last, in his sixty-sixth year after a long illness, had been a member of the Royal Society of Arts since 1899.

Born in 1851, Mr. Oakey, at the age of sixteen, entered the business of his father, John Oakey, in Blackfriars Road. Later on the firm was transferred to Westminster Bridge Road, where the well-known Wellington Mills were built. In 1892 the firm was formed into a limited company under the title of John Oakey and Sons, Limited, and

they carried on a very extensive business in the manufacture of emery and black lead, rubber knife-boards, knife polish, silversmiths' soap, and kindred goods. Mr. Herbert Oakey became managing director and chairman of the company, holding the latter position up to the time of his death.

NOTES ON BOOKS.

JOSEPH PENNELL'S PICTURES OF WAR WORK IN ENGLAND. London: William Heinemann; Philadelphia: J. B. Lippincott & Co. 6*s.* net.

Some time ago Mr. Pennell received permission from the authorities to visit the principal munition works in England with the idea of making an artistic record of the mighty industrial effort which is now being made throughout the country. The result of his mission was seen in the remarkable exhibition of drawings which was held in the Guildhall in December last. Of those drawings fifty-one are now collected together and given permanent form in the volume before us.

The first fifty pictures are of subjects directly connected with the manufacture of munitions. They represent various stages in the making of shells, the forging of big guns, the building of ships, etc. Such scenes, both within and without the works, with their extraordinarily bold effects of blaze and blackness, are exactly congenial to Mr. Pennell's genius, and this series of drawings is as fine a piece of work as he has ever done. Taken collectively, they give a wonderful idea of the feverish effort being made by modern science to cope with the appalling demands of modern war.

The subject of the last drawing differs from those of the rest. It is the scene visible every night from the artist's window—the shot-tower standing out black against a lattice-work of searchlights. In the opinion of Mr. H. G. Wells, who writes a preface to the volume, it is the only commonplace subject amongst them all. Few people, we fancy, will endorse this verdict, for the scene is intensely dramatic, and deserves to be put on record as much as any of the others—even though most of us would give anything, like Mr. Pennell himself, never to see it again.

THE REAL GERMAN RIVALRY. By Sir Swire Smith, M.P., LL.D. London: T. Fisher Unwin, Ltd. 1*s.* net.

Sir Swire Smith has been long and honourably known for his services on behalf of technical education in this country. Thanks to the work instituted by him in his native town, Keighley at one time sent more exhibitioners to the Royal Colleges of Science and Art at South Kensington than any other city or town in the kingdom. So remarkable, indeed, was its success that Professor Huxley once declared that Keighley had gone far to solve the technical education problem; and the late Duke of Devonshire, when speaking of the National Association for the Promotion of Technical and Secondary Education, said that, in brief, its object was to induce the rest of the country to follow the example of Keighley.

It will be no surprise, then, for those familiar with the work of Sir Swire Smith to learn that, in the struggle for trade which will come at the end of the war, he sees the salvation of this country in technical education. Most people are at one with him in desiring to see every possible improvement in this direction, and in his efforts will only wish him more power to his elbow; but some of his arguments do not seem to be quite consistent with others. For instance, if commercial superiority depends upon technical training, and if we have been so immeasurably inferior to Germany in this respect for the last forty or fifty years, how does it happen that British exhibits at the Brussels Exhibition were so superior to those of other countries, as Sir Swire Smith says they were? It will hardly do to accept his major premiss for one part of his argument, and at another to declare that our superiority is due to Free Trade.

Again, we do not think that his advocacy of the cause of technical education will gain much from his criticism of our system of liberal education. We have all heard of the boy from the great public school who was of no use to the manufacturer because he knew nothing of drawing, designing or machinery; and who was rejected by the business man because he did not know book-keeping and could not correspond in French and German. The aim of liberal education is obviously quite different from that of technical education—each has its separate function to perform; and while we are far from denying the possibilities of improvement in both, we think that no good will be done by advocating the claims of one at the expense of the other.

With much of what the author says in his section dealing with "To-morrow" we are in cordial agreement. The mass of the people now recognise, as they never recognised before, the value to the country of the skilled mechanic and the highly-trained chemist and engineer. If the war has taught them nothing else, it has taught them this, and there are already hopeful signs that in the future more care and money will be devoted by the authorities both to technical training and to scientific research of the highest kind.

To all interested in the industrial future of this country, we commend Sir Swire Smith's book, for they will find in it much to stimulate their interest, and not least in those passages in which their views may differ from his.

GENERAL NOTES.

Belgian Relief.—Readers of the *Journal* may be interested to learn that the Foreign Office have ordered 5,500 reprints of the issue of January 26th, 1917, containing Mr. W. A. M. Goode's paper on "Relief Work in Belgium," to be used for propaganda purposes.

Silkworm Production in France.—Although the production of cocoons last year in France was slightly greater than that of the previous season, the latest official returns show a considerable decrease in the silk harvest since the outbreak of the war. According to these figures, the total number of silkworm rearers in that country was 52,756 last year, as compared with 48,327 in 1915 and 83,823 in 1914. The quantity of eggs hatched in each of these years was 60,305 oz. (of 25 grammes), 49,132 oz., and 108,943 oz. respectively. The total weights of raw (live) cocoons produced each year was :—

	Kilograms.	English lb.
1916	2,797,295	6,167,035
1915	1,738,504	3,833,401
1914	5,067,392	11,173,599

The average yield of silk cocoons per ounce of eggs during the last three seasons was :—

1916	46 kilogs	380 grammes.
1915	35 ,,	384 ,,
1914	46 ,,	514 ,,

The average prices realised last year were 4·35 francs per kilog, as compared with only 2·45 francs in 1915 and 4·01 francs in 1914.

Dried Pepper Industry in Hawaii.—The correspondent at Honolulu of the United States Department of Commerce reports that many inquiries have recently been received there concerning the common small red Hawaiian peppers. Since a quarantine was placed on several fruits and other products of the Hawaiian Islands by the California authorities, on account of the report that the Mediterranean fly had infested some of the products of the islands, the pepper is no longer grown there on a commercial scale. Practically every Hawaiian has pepper plants around his house for home use, but none are now grown for drying or exporting. These peppers are very easily raised all over the islands, and if a good market could be found for the dried product the Territorial Marketing Division, conducted under the supervision of the United States Experiment Station at Honolulu, believes that the industry could be established on a profitable basis. An official of the Territorial Marketing Division states that an attempt was made by the division a short time ago to establish the dried-pepper industry at Honolulu, using Anaheim Chili pepper, but without result. Peppers can be shipped in a dried state to the United States; but there is a quarantine against the fresh product, owing to its susceptibility to the melon fly. The producer would have to get about 8½*d.* a lb. for the dried product f.o.b. Honolulu to make it a paying business.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

February 28.—Francis A. Hocking, B.Sc., Pharmaceutist to the London Hospital, "The War and our Supply of Drugs." Robert Hutchison, M.D., F.R.C.P., will preside.

March 7.—James Harris Vickery, LL.B., "German Business Methods."

March 14.—Dr. J. Augustus Voelcker, "Fertilisers and their Supply in War Time."

March 21.—G. W. Jones, "Colour Printing and some Recent Developments." Carmichael Thomas, Chairman of the *Graphic* and *Daily Graphic*, will preside.

April 18. — Horace M. Thornton, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

April 25.—Sir Francis Fox, M.Inst.C.E., "Flour and Bread." Captain Charles Bathurst, M.P., Parliamentary Secretary, Ministry of Food, will preside.

Indian Section.

Thursday afternoons, at 4.30 p.m. :—

March 15.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

April 19.—D. T. Chadwick, I.C.S., "The Future of Indian Trade with Russia and France."

May 17.—Surgeon-General Sir C. Pardey Lukis, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

February 27. — Alfred Bigland, M.P., "The Empire's Assets and how to use them." W. A. S. Hewins, M.P., will preside.

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

DR. M. HORN, "The Economic Development of the Belgian Congo."

PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency."

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m.:—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

Syllabus.

LECTURE I.—MARCH 5.—The spirit of memorial design—Art sacrifice and utility—The matter of inscriptions—Development of various monumental types and conventions—Praying figures—Canopied monuments—Mural tablets—The placing of monuments in buildings—Historical sketch.

LECTURE II.—MARCH 12.—The designing of modern monuments—Architect and sculptor—Influence of setting—Adoption of historical styles—Choice and treatment of materials—Brass, stone, marble, wood, lead—Lettering—Heraldry—Emblems and symbols—Christian feeling in memorial art—Crosses and Calvaries—The churchyard.

LECTURE III.—MARCH 19.—Equestrian figures—Group memorials—Public school, regimental and civic monuments—The War memorial—Teuton *versus* Latin spirit in design—The Christ of the Andes — Columns and arches — Buildings and bridges—Monumental art and town planning.

HOWARD LECTURES.

Monday afternoons, at 4 p.m.:—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies: (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market." Two Lectures.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 26 ... East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Mr. T. H. S. Biddulph, "The Native States of India in their relation to the Paramount Power."

TUESDAY, FEBRUARY 27 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. A. Bigland, "The Empire's Assets and how to use them."

Arts, Royal Academy of, Piccadilly, W., 3.30 p.m. Mr. C. Dodgson, "Old Engravings."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. E. Dalby, "The Strength and Structure of Metals." (Lecture I.)

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7 p.m. Mr. J. Shepherd, "Some Points in Connection with Engineering Specifications."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. E. W. Mellor, "A Chronological Survey of some Landmarks of Ancient Egypt."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Major A. J. O'Brien, "The Criminal in the Western Punjab."

Colonial Institute, Caxton Hall, Westminster, S.W., 4 p.m. Mrs. Blount, "The Yukon River from Source to Sea."

WEDNESDAY, FEBRUARY 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. F. A. Hocking, "The War and Our Supply of Drugs."

Pottery and Glass Trades Institution, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. W. G. Savage, "The Protection of the Milk Supply."

Oriental Studies, School of, London Institution, Finsbury-circus, E.C., 5 p.m. M. de Z. Wickremasinghe, "Ceylon during XVIth and XVIIth Centuries."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor Gerothwohl, "The Entente and the New Humanities."

THURSDAY, MARCH 1...Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Mr. J. C. Mottram, "Some Observations on the Feeding-habits of Fish and Birds with special reference to warning Coloration." 2. Dr. D. H. Scott, "The Heterangiums of the British Coal-Measures."

Chemical Society, Burlington House, W., 8.30 p.m. 1. Mr. J. A. N. Friend, "Notes on the effect of heat and oxidation on linseed oil." 2. Messrs. G. T. Morgan and A. W. H. Upton, "Acyl derivatives of paradiazoiminobenzene."

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. S. Prior, "Memorial Art To-day." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. A. Maude, "Russia and its Writers."

Arts, Royal Academy of, Piccadilly, W., 3.30 p.m. Mr. F. M. Fletcher, "Woodcuts in Colour."

FRIDAY, MARCH 2...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. W. H. Godfrey, "Chelsea."

Royal Institution, Albemarle-street, W., 5.30 p.m. Mr. C. F. Cross, "Cellulose and Chemical Industry, 1866-1916."

University of London, University College, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture VII.)

Economics and Political Science, London School of, Clare Market, W.C., 8 p.m. Mr. H. Rathbone, "The Wheat Supply of Great Britain."

SATURDAY, MARCH 3...Royal Institution, Albemarle-street, W., 3 p.m. Mr. D. Jones, "The Pronunciation of English at the time of Shakespeare." (Lecture II.)

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 3 p.m. Verhaeren Celebration.

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FRIDAY, MARCH 2, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 5th, at 4.30 p.m. (Aldred Lecture.) LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." (Lecture I.)

TUESDAY, MARCH 6th, at 4.30 p.m. (Colonial Section.) MONSIEUR M. HORN, LL.D. (Brussels), "The Economic Development of the Belgian Congo." A. D. STEEL-MAITLAND, M.P., Parliamentary Secretary, Colonial Office, will preside.

WEDNESDAY, MARCH 7th, at 4.30 p.m. (Ordinary Meeting.) JAMES HARRIS VICKERY, LL.B., "German Business Methods." The RIGHT HON. SIR GEORGE HOUSTON REID, G.C.B., G.C.M.G., K.C., M.P., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COLONIAL SECTION.

Tuesday afternoon, February 27th, 4.30 p.m.; MR. W. A. S. HEWINS, M.P., in the chair. A paper on "The Empire's Assets and how to use them," was read by Mr. ALFRED BIGLAND, M.P.

The paper and discussion will be published in a subsequent number of the *Journal*, though, in consequence of the restriction of paper supplies, there will be some unavoidable delay before they can appear.

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 28th, 1917; ROBERT HUTCHISON, M.D., F.R.C.P., in the chair.

The following candidates were proposed for election as Fellows of the Society :—

Bartle, George William, M.I.Mar.Eng., A.M.I. Mech.E., 27A, Mile End-road, E.

Das, Manmatha Nath, B.A., A.M.I.Mech.E., 19, Waverley House, Kenton-street, Russell-square, W.C.

Edwards, R. Jestyn, Brynawel, Alltwen, Pontardawe, Glamorgan.

Wolseley, Lady, Wolseley, Stafford; and Brown's Hotel, Albemarle-street, W.

The following candidates were balloted for and duly elected Fellows of the Society :—

Bertrand, J. F., Isle Verte, Temiscouata County, Quebec, Canada.

Chrimes, Thomas Edward, R.N.A.S., Holmcroft Wilbury Villas, Hove, Sussex.

Comber, Joseph Forstall, Assoc.Inst.C.E., The Lagunas Syndicate, Ltd., Oficina North Lagunas, Iquique, Chile.

Eckford, Captain George, R.E., The Old House, Milston, Salisbury.

Lewis, Nolan D. C., M.D., Crownsville State Hospital, Crownsville, Maryland, U.S.A.

Loring, Mrs. William Caleb, 2, Gloucester-street (corner of Beacon-street), Boston, Massachusetts, U.S.A.

The paper read was—

THE WAR AND OUR SUPPLY OF DRUGS.

By F. A. HOCKING, B.Sc.,
Pharmaceutist to the London Hospital.

The privilege of reading a paper before the Royal Society of Arts affords an opportunity of presenting this subject from a point of view which has not received much attention from the various writers and speakers who have hitherto taken part in its discussion.

A number of papers have been written by gentlemen undoubtedly highly qualified to give most valuable advice of a botanical, horticultural, and chemical nature, and no aspect of the question seems to have escaped full discussion save one, and that the most important. According to the published reports, little or no attempt appears to have been made to ascertain definitely what drugs actually are employed in the treatment of disease, and consequently there has been a tendency to expend, somewhat uselessly, time, trouble, skill, and technical knowledge, to say nothing of printer's ink, upon unimportant divisions of the subject.

In times such as the present, attention should be concentrated upon those drugs which experience has demonstrated to be actually helpful, and hence necessary, to the treatment of disease, and I submit that the most reliable testimony to the value or otherwise of drugs is provided by the practice of the great general hospitals at which the future medical man or woman receives his or her training in the methods employed in the treatment of disease; for the various methods employed *to-day* in these institutions in alleviating physical suffering are precisely the methods which will be employed in private practice *to-morrow*, when those men and women have graduated from these centres of medical and surgical education.

And, as I have the honour to serve in the largest voluntary hospital in the kingdom, I trust I may be excused if I base many of my remarks upon the practice of the London Hospital, which, with its 17,000 in-patients and 170,000 out-patients annually, affords very valuable and representative data for a discussion such as the present.

It is proposed to divide the subject into three sections and consider :—

1. What drugs were in use before the war, and to indicate to what extent we were dependent upon Central Europe for their supply.

2. The difficulties arising out of the war, and to what extent these have been surmounted.

3. The period after the war.

I.—The Drugs in Use before the War and their Origin.

It may be advisable to remark that in using the term "drug" the reference is not to the forms in which they are administered, but to the original materials of which these latter are compounded. An illustration will make this clear. Cascara bark is the drug; the Liquid Extract or the Tablet is the form of its administration.

It is also desirable to point out that new remedies are often composed of very simple and well-known constituents. Thus the antiseptic solution known as Eusol is made entirely from the familiar substances Boric Acid, Chlorinated Lime, and water.

Our concern at present is solely with the drug, not with the forms in which it is used.

In reviewing the drugs in use before the war it will be convenient to consider them in seven groups.

The First comprises medicinal plants.

Much misconception exists regarding both the importance of the members of this group and the extent to which they are employed, due partly to the fact that the experts who have been consulted, while of undoubted eminence in their knowledge of the botanical characters and microscopic structures of medicinal plants, are not in close touch with actual medical and surgical practice.

Societies have been formed, lectures given, and books written urging, on patriotic grounds, the cultivation of medicinal plants in this country; but one would like to have seen more attention paid to the question as to whether this is necessary, and, if so, to what extent.

"Times have changed" is a trite saying peculiarly applicable to the use of vegetable drugs. Formerly the physician derived his principal, and perhaps more numerous, remedies from the vegetable kingdom; but in recent years a variety of circumstances has contributed to bring about a material change.

New methods of treatment have been devised which do not necessarily involve the use of drugs, such as the employment of Sera and of Vaccines, and of physical agents, as electricity, light, etc. As the Regius Professor of Physics at Cambridge says :—

"We are learning also the virtues of high altitudes, of climates and other natural conditions, as we are discovering more and more new resources in other physical means—in rest cures, passive and active exercises, respiratory gymnastics, electric and ray therapeutics, radio-activity, diathermy, and so forth."

The greatly extended use of substances of definite chemical composition derived from the mineral kingdom or prepared in the chemical laboratory has tended to reduce the use of vegetable drugs, for the constant composition of the former presents great advantages over the often varying constituents of the latter.

For these and other reasons it comes about that, of the large numbers of drugs described in a text-book of Vegetable Materia Medica, some are occasionally prescribed by medical practitioners of a past or passing generation who still adhere to what Sir Clifford Allbutt calls "the blind and formal drug-mongering of the elder tradition in the practice of physic"; some are to be seen only in a museum; some are constituents of the "heal-alls" of domestic medicine; and others are in demand by the patent medicine proprietor who grows wealthy by reason of the childish faith of an all-too-credulous British public.

The list of drugs actually used in the London Hospital in the year 1914, for the purpose of

this paper regarded as a peace year, includes about eighty of vegetable origin.

Of this number some, such as Alkanet Root, are used merely for colouring; others, as Orange Peel, for flavouring; and some, as Orris Root, for perfuming; while a few, as Tragacanth, are employed for pharmaceutical, as distinguished from medical, purposes.

On looking at the geographical sources of the most important, we soon discover that very few indeed are derived from Central Europe.

Several are cultivated or grow wild within the borders of the British Empire; thus:—

Cinchona bark comes from India and Ceylon, as well as, of course, from non-British parts of the world.

Cinnamon bark from Ceylon.

Buchu leaves from South Africa.

Senna leaves from India, and also Egypt.

Quassia wood from Jamaica.

Nux vomica seeds, the source of strychnine, from India.

Castor-oil seeds also from India, as well as Sandal-wood oil.

Ipecacuanha root of sound quality comes from Johore.

Many come from non-European countries outside our Empire, such as:—

Camphor, which is a Japanese Government monopoly.

Cascara bark from the United States of America.

Calumba root from Africa.

Ipecacuanha root from Central America as well as from previously named source.

Rhubarb root from China.

Of those which are supplied by Europe, some are imported from neutral or allied countries—thus, Ergot comes from Russia and Spain, Squill from the Mediterranean shores.

Ultimately we arrive at a short list of medicinal plants, not exceeding eight in number, formerly derived from enemy countries. They are Aconite Root, Belladonna Root and Leaves, Colchicum Corm, Digitalis Leaves, Gentian Root, Henbane Leaves, Opium, and possibly Valerian Root. Of these it is generally admitted that Digitalis grows wild in this country in sufficient quantity for all our needs. And I am informed that very large quantities of wild colchicum corms, *i.e.* meadow saffron, have been gathered in this country during the past two years; hence little difficulty seems to exist.

For opium we are not entirely dependent on Eastern Europe, Persian opium having been for long an article of commerce, and since the outbreak of war Indian opium has been imported for the production of morphine—in fact, the world's supply of this alkaloid is to-day practically all produced from Indian opium.

Gentian root is but one of a number of bitters of equal value; hence any deficiency is not of great importance.

Indian or Japanese Aconite might be used probably to supply any shortage of the European article.

The real difficulties were in connection with Belladonna root and leaves, Hyoscyamus leaves, and possibly Valerian. There may perhaps be one or two others which have a localised use in different parts of the country. The past tense is used because Egyptian henbane tends to render the cultivation of other Solanaceous plants a matter of indifference, and Japanese Valerian Root has been used for the European article.

It is difficult to estimate accurately the real extent of the deficiency because, for instance, while some people bemoan the shortage of English belladonna root, yet others are able to obtain their requirements; thus the London Hospital secured 1 cwt. of excellent root (wild) from Hampshire.

The shortage of belladonna and foxglove leaves cannot be so great as is supposed, for even during the war appreciable quantities of the English-grown products have been exported.

Even if the cultivation of these few plants be necessary, much caution is required. It cannot be stated too often that the demand is and must be strictly limited.

Drugs are, or should be, for the sick only, who constitute, it is hoped, a minority of the population; further, Belladonna, Foxglove, and other essential plants are often poisonous in large quantity; hence medicinal doses are very small.

In view of these two facts, it needs no expert knowledge to realise that a very little over-production will soon render these drugs a glut on the market, and so reduce prices to a non-remunerative level.

Probably we may rely upon the business enterprise of the proprietors of the old-established drug farms of this country to meet in some degree at least the problem arising out of the present situation.

In view of what has been said, it seems that too much attention has been directed to a difficulty which is scarcely so urgent as has been represented; hence, may it not be asked if the energy at present being devoted to growing

medicinal drugs might not be better utilised in the production of foodstuffs?

A Second group comprises about fifteen substances obtained from the animal kingdom. Of these one was exclusively German, namely Lanolin, the fat of sheep's wool—a very useful basis for ointments. With this exception no one country can claim a monopoly of such articles as beeswax, honey, pepsin, and dry thyroid gland.

The Third group comprises the extremely important class of substance known as Alkaloids, obtained from plants gathered from the ends of the earth.

It will be convenient here to call to mind that much has been written and said concerning our real or supposed dependence on Germany for medicinal chemicals, and for the most part the view taken has been accompanied by some exaggeration. It is most undesirable to commit the fatal mistake of underrating one's enemy or competitor, but in avoiding this error it is surely not necessary to fall into the opposite one of unduly depreciating the abilities and resources of our own country. The jeremiads uttered by some would lead us to believe that Germany was the source of all drugs of any importance, and that with the outbreak of war supplies ceased!

In order to correct this extreme view, it is proposed to indicate in this and succeeding groups the more important chemicals used in medicine, and to note very briefly to what extent we were dependent on Germany.

The number of alkaloids or their salts used in the London Hospital in the year 1914 was about fifteen. Of these, seven—namely, Apomorphine, Acetomorphine, Morphine, Codeine, Caffeine, Strychnine, and Emetine—were, and of course are, manufactured in England on a large scale, not merely for home consumption, but also for export to all parts of the world, and we may claim that for both quality and quantity the English products were easily first.

It is true Germany sold these drugs, but it is not easy to determine what proportion was of German manufacture and what of English manufacture bearing a German label, for it is an established fact that the Teuton imported appreciable quantities of these British-made alkaloids.

With reference to Quinine, one cannot claim that English Quinine dominated the world, for it is produced in the United States of America, France, Germany and Italy; but the home manufacturer had a good share of the world's trade, and, as regards the quality of English Quinine salts, an official investigation by the Italian Government some years ago showed them to be second to none.

The two alkaloids Cocaine and Theobromine were manufactured in this country, but relatively not on a large scale.

For the remaining alkaloids in the list we were undoubtedly dependent on enemy countries, as the very small quantities that may have been made here were almost negligible. They include Atropine, Eserine, and Homatropine, so very important in ophthalmic practice, as well as some alkaloids of less frequent use.

It is of interest to note that the alkaloid, Acetomorphine, was discovered by a Scotch chemist, and subsequently manufactured and put on the market by the Teuton, who, however, had to purchase English morphine for its production. While another, Cotarnine, was also put on the English market by a British firm long before the German product was boomed under a fancy name.

The Fourth group embraces about twenty chemicals known as *acids*.

Four, including lactic and tannic acids, were probably German; the remainder are English products, prepared in some instances from raw materials existing here, and in other instances from raw material imported from non-European countries, but the supply of which is largely controlled by British capital and enterprise, as in the case of Boric Acid. The raw material for Citric Acid is an Italian Government monopoly.

The Fifth group is composed of a large number of compounds of the common, and of the less familiar metals usually called salts.

It would be tedious to give any detailed account of the sources of these drugs. The group includes important remedies, as Calomel, Corrosive Sublimate, Nitrate of Silver, Bismuth Carbonate, Sulphate of Iron, Sodium Bicarbonate, Potassium Bromide and Iodide, and many others well known to all. It will suffice to state that we depend upon home production for the majority of these compounds. For many the raw material is found in England, for others, as bismuth, it is imported from America; for some, as mercury, from Spain; and for others, by no means the least important, from Germany. Reference will be made to this a little later.

The Sixth group embraces the simple compounds of Carbon, to the number of nearly twenty, sometimes known as "Organic Chemicals"—a name also applicable to the next group

which, however, possess a more complex composition.

The majority of the twenty simple compounds of Carbon are of great importance to the physician and surgeon. The group includes the general anæsthetics, Ether, Chloroform, and Ethyl chloride; the antiseptics, Carbolic Acid, Creosote and Iodoform, and also the well-known liquids alcohol and glycerine, so essential to pharmacy. Mere mention of the names of these substances is sufficient indication of their invaluable character. All of these were and, of course, are produced here in large quantities and of indisputable quality.

The other articles in this group are of much less importance. Three are of Teutonic origin, and the remainder English or American productions.

The Seventh group, comprising the complex compounds of Carbon, contains about forty drugs commonly known as the Synthetics.

The pre-war source of the great majority was, it must be confessed, Germany; very few of them were obtainable elsewhere, except possibly from Switzerland. France produced the very important substance adrenalin (synthetic), so largely used in surgical work, and also digitalin. An English house made Chlorbutol, and occasionally small quantities of two or three others; but for more than thirty out of the forty we were dependent on Central Europe.

The members of this group are not all of equal importance. One or two are dyes, used merely to give a distinctive colour to certain lotions, and one or two are substances whose medical value has not been fully established; but the majority comprises some very important drugs, such as Antipyrin, Chloral hydrate, Novocain, Phenacetin, Resorcin, Saccharin, Salicylic Acid, and its compounds Aspirin and Salol and Veronal, together with Salvarsan and Neo-Salvarsan

It is foolish either to minimise the importance of these drugs, or to detract from the work accomplished by the Teuton in their production, or to disguise our pre-war dependence on Germany for supplies. But, at the same time, we should not commit the mistake of supposing that synthetic drugs constitute the whole Materia Medica, for, as I have endeavoured to indicate, there are a large number of no less important drugs which were and are pre-eminently English products. It is, therefore, necessary to look at the matter of synthetic drugs in its proper perspective.

In these groups of drugs no reference has been made directly or indirectly to various preparations which bulk largely in the advertisement columns of the public press. For the most part they contain or are made up of quite ordinary substances, to which more or less fancy names have been given.

Two may be cited as illustrations—Lysol and Formamints. There is nothing mysterious about either of these articles except the names, and it may interest this audience to know that identical equivalents for both of these articles could be obtained of British manufacture for years before the war began; but, of course, they were not designated by the protected Teutonic names.

The London, in common with many other hospitals, used an antiseptic fluid identical in composition with and of equal value to Lysol at a cost, for the English article, of less than one-half that of the German.

Similarly, every pharmacy in the country sold English manufactured lozenges and tablets the equal of Formamints in all respects. Hence, it would appear that Lord Rhondda has brought his goods to the fair a day too late.

Having thus sketched lightly the position before the war, we can now pass to the consideration of—

II.—The Difficulties arising out of the War, and to what extent these have been surmounted.

With the outbreak of war there was also an outbreak of profiteering. Whether or not profiteering has been practised in other trades I do not know, but it is well known that in the drug trade certain firms—not, however, manufacturers, but dealers—threw any patriotism they may have had to the winds, and seized every opportunity of gaining control of the existing stocks, and also of the future output of home manufacturers, and then advanced prices entirely in their own interests, and thus made money out of the consumers' embarrassments, and were this a suitable occasion full details could be given. For instance, war had not been declared a fortnight before certain firms, warmly professing great consideration for their clients, assured them they had no desire to reap any advantage from the conditions created by the war; which desire they proceeded to manifest by practically repudiating their contracts and by raising, or attempting to raise, prices all round, even on drugs obtained from non-European countries.

Manufacturers, while making no promises,

loyally fulfilled their contracts, even though, in the case of one or two drugs, at a loss to themselves.

For a second instance we may take the case where the manufacturers' output of a certain drug had been secured for some months ahead by middlemen. These latter, taking advantage of the position created by themselves, advanced the price by 20 per cent. to 50 per cent., and, in one instance, a profit of many hundreds of pounds was made by a firm who neither saw nor handled the goods they sold.

This difficulty may be regarded as in some sense avoidable.

The real difficulties were comparatively few, but very formidable, and became intensified as the British blockade of Germany became more stringent. They were associated mainly with—

1. The supply of raw material, particularly of potash and of bromine.

2. The supply of synthetic and some other drugs.

A number of compounds of potassium are used in medicine, the raw material for which was obtained from Central Europe for the reason that Nature has endowed Germany with huge deposits of two potassium compounds—Kainite and Carnallite—which could be and were exported at such a price as to render all other sources of potashes unremunerative to work.

On the declaration of war inquiries were instituted to discover other sources of supply, and the Imperial Institute has published the results in a pamphlet entitled "The World's Supply of Potash."

Supplies may result from the revival of the kelp industry in Scotland and Ireland; but these are temporary, as the cost of production renders competition with the Stassfürt supplies impossible. Hopes are entertained that the discovery of large deposits of potash minerals in Spain may prove a serious competitor to the Germans in the future. It is, however, necessary to remember that the main difficulty lies chiefly in the direction of supplying potash for artificial manures, for the relatively small requirements of medicine and of the arts have been met without very great difficulty, but, of course, at a high price.

Prior to the war the world's supply of bromine was derived from the United States of America and from Germany, and the producers in these two countries had entered into arrangements whereby competition was largely eliminated, in consequence of which the Americans kept away from European markets.

The blockade left the Americans masters of the situation—a fact of which they were not slow to take advantage, for at one time the price of potassium bromide was 25*s.* per lb., as compared with 1*s.* 6½*d.* per lb. in July, 1914.

This serves to illustrate what we have had to pay for drugs for which England has had to depend during the war entirely on neutral countries, and it is instructive to set beside this enormous rise in price the moderate variations in respect of the prices of drugs the raw material for which is obtained within the Empire or is controlled by British enterprise and capital. Two instances will suffice for comparison. The production of Iodine from Chili saltpetre is largely controlled by Britain; hence the price of Potassium Iodide, which in July, 1914, was 12*s.* per lb., rose to 15*s.* per lb. only in December, 1915, and has since fallen to 12*s.* 2*d.* per lb., practically the pre-war price.

Similarly, the price of Morphine in July, 1914, was 9*s.* per ounce. On the outbreak of war with Turkey it rose to 13*s.* 6*d.* per oz., at which price it still remains. Had the control of Iodine and of Opium been in the hands of neutral nations the prices to which Potassium Iodide and Morphine would have risen baffle imagination.

Bromine, however, is now being prepared in France from sea water in large quantities, and at a price which enables it to compete with the American product.

These two problems of potash and of bromine, so essential in the treatment of nervous disorders, do not seem to have attracted public attention to the same extent as the question of synthetic drugs, to which we now turn.

A great deal of undeserved blame has been heaped on the heads of English firms manufacturing medicinal chemicals because they did not immediately undertake the production of these synthetic drugs, and the question has been frequently put, Why do not English firms commence the manufacture of these drugs and capture German trade?

Well, in the first place, the resources of British firms were taxed to the utmost in their endeavour to cope with the sudden and enormous demand for essentially British products for the needs of the Allied armies and of the civil populations; hence they had neither time nor staff to devote to fresh work.

The extent of these demands far exceeds the conception of all who are not directly associated with this work.

In the next place, it is to be remembered that you cannot raise armies of millions of men and have at the same time a surplus of labour to draw upon for new commercial enterprises, and

if you could it is not to be expected that plant and processes can be improvised in a day, which have occupied the enemy years of thought and labour in bringing to their present state of perfection.

Moreover, as has been pointed out by more than one distinguished scientist, it is one thing to make a trifling quantity of a drug in a laboratory, but quite another thing to produce the same article by the hundredweight and ton. The problem requires, not only the science of the chemist, but also the knowledge of the engineer to design the plant as well as the manual skill of the mechanic for its construction.

For these and other reasons very little was done in the early months of the war.

A start was, however, first made in the East End of London with the production of salicylic acid and its compounds, possibly because the raw materials are easily obtainable and because the process of manufacture is relatively simple, and in the early spring of 1915 the London Hospital received 1 cwt. of British-made sodium salicylate of excellent quality.

Aspirin was the next item to be tackled, and although the early attempts were not satisfactory, difficulties have now been surmounted, and more than one manufacturer is turning out tons of this article of the highest degree of purity.

Atropine sulphate, so essential in ophthalmic practice, and originally derived from Central Europe, is now being produced from Egyptian henbane in large quantities by at least two English firms.

It is unnecessary to weary you with detailed records of recent British achievements. It will suffice to mention a few of the "German" drugs now being produced in this country: Absolute Alcohol, Lanoline, Butyl chloral hydrate, Paraldehyde, Lactic acid, Homatropine, Phenacetin, Saccharin, Salol, Xeroform, Novocain, Salvarsan, and Potassium permanganate.

It is interesting to note that the chemical laboratories and staffs of various university colleges throughout the kingdom have been pressed into this work, and, as an illustration, I may mention that a certain drug supplied to the London Hospital bore a label, "Made in —— laboratory of —— University."

We now pass to the consideration of—

III.—The Period after the War.

This topic alone would suffice for the subject of a lengthy paper, and hence it is possible to indicate but one or two matters.

It will be generally admitted that the scientists of these islands are fully equal to the solution of all questions relating to synthetic drugs involving chemical knowledge both general and particular. And with the passing of the war there will also pass most of the difficulties with which manufacturers have at present to contend, particularly as regards provision of plant and of labour. Discussions of the turn of events after the war have centred, therefore, round what may be termed the commercial and financial aspects of the question.

It is assumed without doubt that the enemy countries will put forth the most strenuous efforts to regain the trade enjoyed by them before the war. Profiting by the lower rate of wages ruling in Germany as compared with those in this country, and aided probably by State subsidies, it is expected they will offer synthetic drugs at prices with which British manufacturers, if left entirely to their own resources, will be unable to compete.

If the production of synthetic drugs established here during the past two years is to survive the war, then some form of State aid seems to be necessary.

Difference of opinion exists as to the form which Government assistance should take. Firms which have had but limited experience of chemical manufacturing on a commercial scale ask for subsidies from Parliament. They desire to buy their experience and to build up a business at the expense of the State.

Firms, however, which are in possession of extended experience in the production of medicinal chemicals, having already tackled the new problem successfully, ask only for State assistance of a legislative character in order to ensure that the newer industries shall have a fair chance of surviving.

Some suggest that importation of synthetic drugs from enemy countries should be entirely prohibited for a period of years following the war; others suggest the imposition of a tariff which, while sufficiently high to give British firms a reasonable chance of competing with the German, should at the same time not be so excessive as to penalise the consumer.

Public bodies which are large consumers of drugs, such as the Voluntary Hospitals and the Municipal and other Infirmaries, can render much help in support of such legislative action by collectively agreeing to refuse to buy synthetic drugs emanating from Central Europe, even though such refusal may involve a slight extra cost to the ratepayer. Is British patriotism

strong enough to support such a step on the part of the governing bodies of these institutions?

The question of legislative assistance is by no means a simple one. For example, how is it proposed to deal with the competition of neutral countries? The United States is already a serious competitor to be reckoned with in the English market, and, in spite of high freights and insurance, the American can sell his goods in England at a lower price than the Englishman. In some cases the difference is not great; in others there is no comparison: thus some tons of American Phenacetin were recently sold in London at about one half the price of the English product.

Is then a tariff to be imposed on all non-British synthetic drugs, or only on the German article?

One writer suggests that money derived from a tariff ought to be devoted to research and education; but if a tariff is to be efficient in keeping out enemy products there will be no income from this source.

British manufacturers and scientists recognise that legislative protection does not by itself constitute a royal road to success.* Co-operation among themselves is highly desirable in arranging that too many firms are not engaged on turning out the same products; it has also been pointed out that by organisation and mutual concession the cost of manufacture can be reduced to a minimum if some firms undertake the production of essential intermediate substances for the use of other firms engaged in working up the ultimate synthetic drug.* Further, it is to be noted that certain intermediate products are required very largely in the dye industry, and upon the development of the latter to some extent depends the success of the synthetic drug industry.

There is a further question upon which there has been much agitation for many years, and concerning which there is also some difference of opinion. Endeavours have been made to persuade successive Governments to grant the use of duty-free alcohol on the grounds that the high duty handicaps the Englishman to such an extent as to make it impossible for him to think of competing with the foreigner who has the advantage of cheap alcohol.

The Government has made some concession in permitting the use of a spirit known as "industrial spirit," containing a smaller quantity of the denaturing constituents, but this does not give universal satisfaction. It may be the question will be investigated once again and further concessions granted.

Another complaint for which there is some justification, and which has occasionally been levelled by home manufacturers against the medical profession, is that new drugs of English manufacture put on the market under systematic names understood by all chemists are coldly received by the physician, but when these same drugs are made in Germany and introduced under a fancy name they are received with open arms. For example, Acetomorphine, already referred to, was first made and introduced in England by a Scotch firm, but little interest was manifested by the medical profession, whereas the same drug put on the market by the Germans, under the name "Heroin," was taken up with alacrity.

Furthermore, the partiality shown by some medical workers in the field of research for German reagents and solutions is difficult to understand, when it is remembered that British reagents of equal purity are easily obtainable.

One other criticism of our system of medical research is the lack of assistance sometimes accorded in physiologically testing newly discovered drugs of British origin.

It is pointed out that the organisation of the German chemical and medical worlds permits of the thorough investigation of the properties of any new remedial agent by experiments on animals, and also by employing it in clinical practice, if there be sufficient ground for expecting good results.

It is urged by some manufacturers that similar co-operation be established between British firms and workers in the field of medical research.

I have now brought to your notice a few points associated with a subject that has been much debated in the lay press, but I am afraid also a little misunderstood; possibly the discussion about to arise may lead to clearer views.

DISCUSSION.

The Chairman (Dr. Robert Hutchison, F.R.C.P.), in opening the discussion, said that, as a physician largely concerned in prescribing drugs, he had been cheered by the author's optimistic estimate of the situation. He had shown conclusively that this country was not so dependent upon enemy countries for important drugs as some people supposed, and that in the future it would be much less dependent upon them than it had been in the past. Except in a few cases there had not been any real difficulty since the war began in obtaining the absolutely necessary drugs, and he

* *See* Mr. Carr's paper, read before the Society of Chemical Industry, on these two points.

doubted if any patient had suffered in consequence of the war from want of a drug. The drugs whose absence had mostly been felt were the synthetic drugs, and the author had explained how it was that this country came to be so dependent on Germany for them. The reason why German synthetic remedies had been so largely taken up was partly because of their fancy names, to which reference had been made. Doctors were busy people and did not like to carry long names in their heads; it was so much easier to remember "Heroin" than "Acetomorphine." A great deal of the success of the Germans was due to getting really clever names for their drugs, and also to their assiduous advertising. Before the war scarcely a month passed but some German commercial traveller walked into a doctor's room with samples of some new remedy, and he had been told by the agent for a tonic food that the proprietors spent £70,000 in advertising the preparation in this country before it began to catch on. That showed to what an extent the Germans were prepared to go in pushing products in the English market. Again, as the author had pointed out, the people in this country had been handicapped to some extent by the want of that intimate co-operation between the scientific people and the manufacturers which existed in Germany, and also through not employing a proportionate amount of trained staff. The close association that existed between the manufacturers and the medical profession in Germany was also absent in this country, to the credit of the medical profession here. It was possible in Germany, by paying a sufficient sum, to get a professor of fair repute to write up in the medical journals any synthetic remedy or patent product produced in the German laboratories. He knew that was the case because he had received offers from German agents to write up their products in the *British Medical Journal* or the *Lancet* in order to get them boomed amongst the English medical profession. They could not understand why he refused those offers, many of which were extremely generous, nor the etiquette of the medical profession which made such things impossible here. Some of the synthetic remedies came on to the market backed by the *imprimatur* of a big name in the German scientific world, but if the real opinion of that German professor could be obtained it would not be very high, and he had simply been paid a large sum to say the best he could for it in print. Manufacturers had also been handicapped in this country from the want of cheap alcohol, and difficulty had arisen in connection with the so-called vivisection question. Rightly or wrongly, obstacles were placed in the way of animal experimentation in this country, even in testing drugs on animals before they were tried on human beings; and all those things, most of which were removable, had stood to some extent in the way of English manufacturers in the past. It was to be hoped that, after the war, the people of this country would make a point of being dependent on nobody but themselves for drugs absolutely essential for the treatment of disease, and maintain the sources of supply in their own hands.

MR. W. GEORGE WHIFFEN said the importance of the supply of the raw materials being under British control was strongly emphasised by what had taken place during the war. Bromine and potassium were of great importance in medicine and in agriculture, and yet—simply owing to the exorbitant demands by the American producers—potassium bromide, which, before the war, sold for 1*s.* 6½*d.*, had risen in price to 25*s.* per lb. Another source of supply was now available, bromine being manufactured in France from sea water, so that the enormous price realised by the Americans would never have to be paid again. Taking the other side of the case, and dealing with articles under British control, the price of strychnine in July 1914 was 1*s.* 7*d.* an ounce; and, in spite of the cost of freight and labour connected with the carriage from India of the nux vomica bean, which was the source of strychnine, the price had only risen to 3*s.* 4*d.* That was due to the fact that a good supply of the raw material had been ensured to the country by the Navy. Similarly, the price of quinine had nearly doubled, being 2*s.* 6*d.* at the present time as compared with 1*s.* 4*d.* before the war, in spite of the high cost of every chemical used in its manufacture, and that was another remarkable instance of the importance of the British control of raw materials. But for the fact that opium was grown within the Empire the price of morphia would probably have been sovereigns per ounce instead of 13*s.* 6*d.*, as it was at the present time. Since the outbreak of war with Turkey the price of opium had not changed. There was no doubt that the group of synthetic drugs which included phenacetin, the salicylates and, salol, was manufactured at the present time to more advantage in America than in this country, owing to the fact that they were not hampered by want of labour and raw materials; in fact, the basis of them, phenol, could only be obtained in this country by permission of the War Office. Since the outbreak of war there had been a very considerable exodus of technical skill of doubtful nationality from Germany to America, and the Americans had properly made good use of it. It therefore did not surprise him to hear that phenacetin of excellent quality could be obtained from the States at a lower price than that at which it could be produced in England at the present time. He had no doubt, however, that in course of time the British would be able to compete with the States in that respect, owing to the high cost of labour and machinery in America in consequence of high tariff duties. There was no better example of the importance of the Empire having control of raw materials than in connection with iodine and the important compounds made from it, such as iodide of potassium, iodide of sodium, and iodoform, which were actually cheaper at the

present time than in June, 1914. All those articles except potassium were under British control, and, in spite of the fact that potassium was worth ten times now what it was in 1914, iodine was cheaper to-day than it was in 1914.

MR. J. C. SHENSTONE thought that, from the commercial point of view, it was the pharmacist's duty to carry out the doctor's orders, and that it was not his place to criticise them. It must be remembered that, although the London Hospital included on its staff a number of eminent medical men, there were many other hospitals in which, although the practice was very similar, a variation in the drugs prescribed was noticeable. It was therefore desirable to consider the question from a wider basis than that of the London Hospital practice. If the author desired to ascertain what all the medical men in the country felt, it would have been better for him to base his remarks on the Codex published by the Pharmaceutical Society, which was the basis of prescriptions received by chemists in every part of the world. He agreed that for purely commercial reasons it was desirable that the drug business should not after the war slip back entirely into the hands of the Germans. He had noticed that the author had not referred to taraxacum, dandelion juice, a very old-fashioned drug, the demand for which was increasing rather than diminishing. He happened to know that at the present time fifty tons of dandelion juice were badly wanted but could not be obtained.

MR. J. E. LANGFORD MOORE thought the optimistic tone of the paper was distinctly encouraging. He crossed swords with the last speaker in reference to the necessity of taking a wider range of the subject than that dealt with by the author, who had had a considerable experience of drugs. His own twenty-five years' hospital experience led him to believe there was a distinct diminution in the variety of drugs used, and that would continue in the future, because it was obvious, as education advanced and physiological problems were cleared up, that reliance would be placed a good deal more on particular drugs than had been the case in the past. The unfortunate experience the country had been through since the war had taught the lesson that there were a great many drugs that it was possible to do without very well, and he saw no reason why they should ever return. The author had omitted one side of the problem connected with the future which it appeared to him needed careful watching, namely, that our greatest competitors in regard to drugs would not be the enemy States in Central Europe, but the countries of the East, such as Japan and China. That was very apparent in view of what was happening with regard to Indian trade, but the difficulty might be set right in the future when the tariff question came up for consideration.

MR. F. RANSOM thought that those who attempted to grow certain herbs on a large scale in this country might be doomed to disappointment, and he therefore desired to utter a word of warning on that question. Although belladonna at present fetched ten times the price it did before the war, it was very undesirable that more belladonna should be produced than the world required. The same remark also applied to henbane, and it was a question whether the species obtained from Russia was exactly the same as that cultivated in this country. If Egyptian henbane eventually superseded all solanaceous plants it was unnecessary to consider the future of belladonna or henbane, because there was an inexhaustible supply of Egyptian henbane. There was enough digitalis in the country to supply the whole world, but the difficulty was to get it collected. Before the war, good dry digitalis from Europe was sold at 25*s.* to 30*s.* a hundredweight, which was not sufficient to pay for the cost of collection in this country. If it could be collected more cheaply plenty of the plant was available. Gentian, which the author had stated came entirely from Central Europe, was now imported from Spain in considerable quantities, and there was no reason why England should not continue to obtain it from there. Styrax, which was now almost unobtainable, came almost entirely from the Turkish Empire, and he did not think the country would suffer much if it never imported any of it again.

LIEUT.-COLONEL ALLAN J. C. CUNNINGHAM mentioned that *datura stramonium*, which the author had not referred to, was used in many preparations for the relief of asthma; it could be obtained in large quantities in India, and was well known to the professional poisoners there. The Chairman had stated that he thought the people of the country had not suffered much from the want of drugs through the war; but a friend of his, who suffered from a serious affection of the mouth, for which he had been prescribed a glycerine wash by his doctor, could not obtain it from the chemist, owing to the fact that the Government had recently commandeered all glycerine.

MR. OSWALD E. BENNETT said he had been much interested in the point raised whether the control of crude material necessarily implied an advantage to this country. He believed that the control of the sources of iodine was the main reason why the potassium iodide was so much higher in price than bromide, and if it were not for that control it might have been sold at a much lower figure. It was well to remember that unless the country could be sure of the patriotism of the individuals who controlled the supplies, it did not follow that the people would be advantaged by control rather than by freer competition.

MR. J. C. PHILIP said that he had been working in connection with the Royal Society Committee which organised the production of drugs in the colleges and universities, and desired to emphasise the fact that the necessity for their production

in those places had now been removed, owing to the enterprise of manufacturing firms. Although in the early days of the war commercial firms were not in a position to undertake the production of synthetic drugs, the situation had been revolutionised in the last twelve months. He was surprised to hear the author say that potassium permanganate was being made in the country at the present time. The information he possessed was that it was sodium permanganate. He was informed that the total quantity of potassium permanganate in the country did not exceed three tons, but that there were large quantities of sodium permanganate. Reference had been made by the author to the fact that in the past British medical men had depended to a large extent for their reagents on German sources, but he confessed that his experience of English firms in pre-war days was not altogether fortunate. On one occasion when he required pure sodium chloride he found it contained manganese.

Mr. F. A. Hocking, in reply, said he did not think Mr. Shenstone had told the whole of the story in connection with the fifty tons of taraxacum that he had said was required. He happened to know that it was not wanted for home consumption at all, but for export to some patent medicine vendors in the States; and he told his informant, who was a partner in one of the big firms of medicinal plant growers, that he would do his best to prevent him getting the fifty tons. He had mentioned that he had taken the London Hospital data as the basis of his paper because it was representative. By that he meant it was not by any means unique, and that the experience was typical of other hospitals. The Codex was a useful book of reference, but there were some things mentioned in it which it was quite impossible to obtain in peace times in this country. There were other books very much more useful. He did not think Mr. Shenstone had made the difference he should between what could be sold and what need be sold. Personally he had concerned himself in the paper with what need be produced, and not with what could be produced in order to find a market. It seemed to him waste of effort and capital in war time to engage in the production of herbs of very doubtful utility. *Datura stramonium*, to which Colonel Cunningham had referred, was used at the London Hospital as a constituent of asthma powder, and he believed it was derived from Europe. It was interesting to know that unlimited supplies could be obtained within the British Empire. The statements that had been made in regard to iodine had reference to a monopoly which existed in peace time. The point he raised was that, monopoly or no monopoly, the fact that British capital controlled the production of iodine had prevented the price of iodine compounds rising so enormously as had been the case with material the control of which was in neutral countries. He believed he was correct in saying that potassium permanganate was being produced, but he was afraid it would be impossible to buy it on the market at the present moment. He also knew that sodium permanganate was being produced, as he had seen the process in actual operation.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Hocking for his paper, and the meeting terminated.

CORRESPONDENCE.

THE BEN-I-ISRAEL.

In reply to Mr. Hylton B. Dale's letter in the *Journal* of February 23rd, I wish to say that Armenia, with Georgia—the Russian form of the Persian *Gurdschistan*, "the Brave-men's land"—roughly comprises the whole of the uplands extended between the Caucasus Mountains and the headwaters of the Euphrates, and between Persia and Asia Minor, and lies, therefore, in the direct line of the southern route of the prehistoric migrations of the Aryan race from some vague place in Central Asia—about the present Desert of Gobi—into Europe, and of every historical conqueror of Anterior Asia from the west, and of Europe from the east.

The name Armenia, for this country, is first found in the cuneiform inscriptions of Darius Hystaspes—"*Armaniya*"—B.C. 486–561; but was probably first used by the Aryan Lydians after the fall of Nineveh in the seventh century B.C. For Sayce has clearly shown, in his "Vanic Inscriptions," that before that date the people of the country were Hittites, who called themselves Viania, or Biania, a name which possibly survives in that of Lake Van. The Assyrian name of the country was *Urartu* [the Hebrew Ararat], meaning, as is thought, "the Mountain of the Moon-Goddess"; and the Lydian word Armenia is said to be a translation of Urartu, in some such original form as *Hara-Meen* or *Hara-Mynas*.

After the Assyrians, Armenia was successively ruled by the Persians, Greeks [Seleucidæ and Arsacidæ], Parthians, and Romans, and again by the Byzantine Greeks and Saracens; and then, from A.D. 859 to 1045, by *the noble Jewish* dynasty of the Bagratides. In the thirteenth to fourteenth century it was subjugated by the Turks, and is now divided between the Turks, Persians, and Russians.

The people of a country so situated, and with so terrible a history, though they may be of one language and one religion, must necessarily be of very mixed race; and, as everywhere, the features and general physique of a man are the surest indications of his race, no one who has known the Armenians in India, and Persia,

and Egypt, and here in England, can have any doubt of their being partly of Hebrew descent. The very Ben-i-Israel themselves, as I have seen them myself low down the Euphrates, and in India, frequently present aquiline noses, betraying the admixture of Aryan with Semitic blood; and I have invariably found that any Muslim, Nestorian, or Armenian with a vulturine nose, was an "Israelite indeed," notwithstanding the beguilements of his Gentile religion.

GEORGE BIRDWOOD.

OBITUARY.

WILLIAM HENRY HUNTER, M.Inst.C.E.—Mr. William Henry Hunter, who had been a member of the Royal Society of Arts since 1899, died at Woodley, Cheshire, on February 27th.

He was born in 1849, and educated at the College of Physical Science, Newcastle-upon-Tyne. In 1872 he was appointed resident engineer on the Hylton and Monkwearmouth Railway, and in the following year he was engaged on the reconstruction works of the River Weaver Navigation. This post he held for about nine years, after which he began his connection with the Manchester Ship Canal. He became chief assistant engineer on the design and construction of the canal in 1887; in 1895 he was appointed chief engineer, and on his resignation from this post, after fifteen years' service, he became consulting engineer.

In 1905 Mr. Hunter represented Great Britain on the Board of Consulting Engineers appointed by the President of the United States to consider the plans for the construction of the Panama Canal.

GENERAL NOTES.

DEAFENED SOLDIERS AND SAILORS.—The annual report of the National Bureau for Promoting the General Welfare of the Deaf shows that, amongst its many other activities, the Bureau has not overlooked the case of soldiers and sailors deafened by gun-fire or by shell-shock. Through its instrumentality a number of men have received special treatment at London hospitals. The London County Council is about to establish lip-reading classes for soldiers; and the War Pensions Committee is being urged to make a maintenance grant to such cases, in order to enable them to continue their training in lip-reading. In certain quarters there has been a tendency to belittle the value of lip-reading; but, in the opinion of those best qualified to judge, there is no doubt that this is by far the most satisfactory method of enabling men who have lost their hearing to regain touch with their fellows.

UNIVERSITY OF LONDON WAR LIST.—The Vice-Chancellor of the University of London will be glad to receive the following information with regard to members of the University who have served or are serving in His Majesty's Forces: Name (Christian names in full); College and University career; rank and regiment or other unit; particulars of service (including war distinctions, and whether wounded, retired, or fallen); with dates. Address replies to—University of London War List, South Kensington, London, S.W.

VICTORIA AND ALBERT MUSEUM.—The war having temporarily claimed the London residences of the Duke of Buccleuch, the Duke of Devonshire, and the Duke of Westminster, the valuable collections of furniture which they contained have been deposited by their owners on loan in the Victoria and Albert Museum. The principal collection is that lent by the Duke of Buccleuch from Montagu House. It consists, for the most part, of French furniture belonging to the period of Louis XIV. to XVI., and includes a remarkable series of Boule examples; pieces signed by Carlin and Joseph; chairs and screens covered with Beauvais and Gobelins tapestry; and many other valuable specimens. The collection lent by the Duke of Devonshire from Devonshire House consists almost entirely of furniture designed by William Kent, the architect of that house when it was rebuilt in 1734, after a fire in the preceding year. It includes about twenty typical examples of Kent's work, and thus will afford to students a unique opportunity of studying the characteristic style of this important artist. Among the pieces lent by the Duke of Westminster from Grosvenor House, the most striking are a pair of Boule *armoires*, similar to the well-known examples in the Wallace Collection and at Windsor Castle.

THE INSTITUTE OF METALS.—The annual general meeting of the Institute of Metals will be held in the rooms of the Chemical Society, Burlington House, Piccadilly, W., on Wednesday, March 21st, and Thursday, March 22nd, 1917. The following communications will be submitted: (1) "The General Properties of Stampings and Chill Castings in Brass of Approximately 60/40 Composition," by Owen W. Ellis, B.Sc. (London); (2) "Machining Properties of Brass," by Owen W. Ellis, B.Sc. (London); (3) "Surface Tension and Cohesion in Metals and Alloys," by Sydney W. Smith, B.Sc., A.R.S.M. (London); (4) "Aluminium Production by Electrolysis: A Note on the Mechanism of the Reaction," by R. Seligman, Ph.Nat.D. (London); (5) "Annealing of Nickel Silver (Part II.)," by F. C. Thompson, D.Met., B.Sc. (Sheffield); (6) "Metal Melting as Practised at the Royal Mint," by W. J. Hocking (London); (7) "Coal Gas as

a Fuel for the Melting of Non-ferrous Alloys," by G. B. Brook (Sheffield); (8) "High Pressure Gas Melting," by C. M. Walter, M.Sc. (Birmingham); (9) "Contribution to Metal Melting Discussion," by H. M. Thornton (London) and H. Hartley, M.Sc. (London); (10) "An Electric Resistance Furnace for Melting in Crucibles," by H. C. Greenwood, D.Sc. (London), and R. S. Hutton, D.Sc. (Sheffield); (11) "Ideals and Limitations in the Melting of Non-ferrous Metals," by Carl Hering (Pa., U.S.A.); (12) "Metal Melting in a Simple Crude Oil Furnace," by H. S. Primrose (Ipswich).

ASBESTOS IN QUEBEC.—The asbestos deposits of Quebec are the most important yet discovered, and are said to supply 80 per cent. of the world's consumption. The principal deposits are at Thetford, Black Lake, Robertsonville, Dunville, and East Broughton, in the counties of Megantic and Richmond. Large mills are in operation preparing the asbestos for the market. The annual production is over 160,000 tons, valued at about $3,850,000, according to the last report of the Mines Branch of the Dominion Department of Mines, and includes a wide variety of grades from the long-fibred crude asbestos, valued at about $400 per ton, down to the shortest mill fibre, valued at only two or three dollars per ton, and asbestic, used for wall plaster, and valued at from 75 cents to $1.50 per ton.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 7.—JAMES HARRIS VICKERY, LL.B., "German Business Methods." The RIGHT HON. SIR GEORGE HOUSTON REID, G.C.B., G.C.M.G., K.C., M.P., will preside.

MARCH 14.—DR. J. AUGUSTUS VOELCKER, "Fertilisers and their Supply in War Time." A. D. HALL, F.R.S., Chairman of the Development Commission and late Director of the Rothamsted Experimental Station, will preside.

MARCH 21.—G. W. JONES, "Colour Printing, and some Recent Developments." CARMICHAEL THOMAS, Chairman of the *Graphic* and *Daily Graphic*, will preside.

APRIL 18. — HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

APRIL 25.—SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

MAY 2.—J. C. SHENSTONE, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

APRIL 19.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

Dates to be announced later:—

D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

MARCH 6. — MONSIEUR M. HORN, LL.D. (Brussels), "The Economic Development of the Belgian Congo." A. D. STEEL-MAITLAND, M.P., Parliamentary Secretary, Colonial Office, will preside.

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency."

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m.:—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

Syllabus.

LECTURE I.—MARCH 5.—The spirit of memorial design—Art sacrifice and utility—The matter of inscriptions—Development of various monumental types and conventions—Praying figures—Canopied monuments—Mural tablets—The placing of monuments in buildings—Historical sketch.

LECTURE II.—MARCH 12.—The designing of modern monuments—Architect and sculptor—Influence of setting—Adoption of historical styles—Choice and treatment of materials—Brass, stone,

marble, wood, lead—Lettering—Heraldry—Emblems and symbols—Christian feeling in memorial art—Crosses and Calvaries—The churchyard.

LECTURE III.—MARCH 19.—Equestrian figures —Group memorials—Public school, regimental and civic monuments—The War memorial—Teuton *versus* Latin spirit in design—The Christ of the Andes — Columns and arches — Buildings and bridges—Monumental art and town planning.

HOWARD LECTURES.

Monday afternoons, at 4 p.m.:—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies: (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market." Two Lectures.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 5...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Aldred Lecture.) Mr. L. Weaver, "Memorials and Monuments." (Lecture I.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. A. W. C. Shelf, "High Tensile Steel *versus* Mild Steel for Reinforced Concrete."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. Mr. W. A. Tookey, "The Composition of Power Gases."

Geographical Society, Burlington-gardens, W., 5.30 p.m. Colonel Sir Francis Younghusband, "Indian Frontier Geography."

TUESDAY, MARCH 6...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Dr. M. Horn, "The Economic Development of the Belgian Congo."

Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Mr. R. Unwin, "Germany: Her Civic Strength and National Weakness."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. E. Dalby, "Internal Combustion Engines." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Arts, Royal Academy of, Piccadilly, W., 3.30 p.m. Sir Frank Short, "Mezzotint."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. J. L. Hodgson, "The Commercial Metering of Air, Gas, and Steam."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. F. C. Reynolds, "Some Simple Experiments with Polarised Light."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. R. I. Pocock, "Exhibition of the work of the Beavers in the Society's Gardens." 2. Dr. F. E. Beddard, "On the Scolex in the Cestode Genus *Duthiersia*, and on the Species of that Genus." 3. Captain S. R. Douglas, "An Experimental Investigation of the Migration of Woodcock Breeding in the West of Ireland."

Faraday Society, at the Chemical Society, Burlington House, W., 8 p.m. Discussion on "The Training and Work of the Chemical Engineer," to be opened by Sir George Beilby. Papers by: 1. Professor F. G. Donnan, "The Training of the Chemical Student for Work in the Factory." 2. Mr. C. R. Darling, "The Training of the Works Chemist in Physics." 3. Mr. W. R. Cooper, "A Plea for the Forgotten Factor in Chemical Training."

WEDNESDAY, MARCH 7... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. H. Vickery, "German Business Methods."

Aëronautical Society of Great Britain, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Professor F. G. Hopkins, "The Selection and Preparation of Foods in War Time."

Oriental Studies, School of, London Institution, Finsbury circus, E.C., 5 p.m. Mr. A. Yusuf Ali, "The Importance of Hindustani."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. J. E. Marsh and O. G. Lye, "The Quantitative Estimation of Mercury in Organic Compounds." 2. Messrs. P. S. Arup, H. C. Huish, and H. D. Richmond, "The Composition of Milk." 3. Mr. H. D. Richmond, (*a*) "Studies in Steam Distillation: Part IV.—Propionic, Butyric, Valeric and Caproic Acids"; (*b*) "Studies in Steam Distillation: Part V.—The Analysis of Acetic Anhydride and Alkyl-Malonic Acids." 4. Mr. J. Webster, "Note on Salvarsan and Neo-Salvarsan."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. A. H. Allcroft, "The Original Castle of William de Warenne and the Early History of the Priory of St. Pancras."

THURSDAY, MARCH 8...Gas Engineers and Managers, Southern District Association of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

City of London College, White-street, Moorfields, E.C., 5.30 p.m. Mr. W. H. Partridge, "Practical Refrigeration in the Retail Meat and Provision Trades."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Dendy, "Sponges: a Study in Evolutionary Biology." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. H. M. Smith, "Practical Demonstrations."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. G. A. Juhlin, "The Voltage Regulation of Rotary Converters."

FRIDAY, MARCH 9...Royal Institution, Albemarle-street, W., 5.30 p.m. Sir Almroth Wright, M.D., "The Treatment of Wounds in War."

University of London, University College, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture VIII.)

Malacological Society, Burlington House, W., 8 p.m. 1. Dr. A. E. Boycott, "The genitalia of *Acanthinula aculeata*." 2. Rev. Dr. A. H. Cooke, (*a*) "The Radula of the genus *Cominella*"; (*b*) "A Colony of *Purpura lapillus* with operculum malformed or absent." 3. Dr. B. B. Woodward, (*a*) "Note on the adventures of the genus name *Lucena*"; (*b*) "Note on the Da Costa plates adapted for Rackett's Edition of Pulteney's Catalogues."

Astronomical Society, Burlington House, 5 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, MARCH 10...Royal Institution, Albemarle-street, W., 3 p.m. Dr. C. W. Saleeby, "Imperial Eugenics—Saving the Soldier." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. 2.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 12th, at 4.30 p.m. (Aldred Lecture.) LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." (Lecture II.)

WEDNESDAY, MARCH 14th, at 4.30 p.m. (Ordinary Meeting.) DR. J. AUGUSTUS VOELCKER, "Fertilisers and their Supply in War Time." A. D. HALL, F.R.S., Member of the Development Commission, and late Director of the Rothamsted Experimental Station, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

ALDRED LECTURE.

On Monday afternoon, March 5th, Mr. LAWRENCE WEAVER, F.S.A., delivered the first lecture of his course on "Memorials and Monuments."

The lectures will be published in the *Journal* during the Summer recess.

COLONIAL SECTION.

Tuesday afternoon, March 6th, 4.30 p.m.; Mr. A. D. STEEL-MAITLAND, M.P., Parliamentary Secretary, Colonial Office, in the chair. A paper on "The Economic Development of the Belgian Congo" was read by MONSIEUR M. HORN, LL.D. (Brussels).

The paper and discussion will be published in a subsequent number of the *Journal*, though, in consequence of the restriction of paper supplies, there will be some unavoidable delay before they can appear.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1917 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 24th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

1864, Sir Rowland Hill, K.C.B., F.R.S.
1865, His Imperial Majesty, Napoleon III.
1866, Michael Faraday, D.C.L., F.R.S.
1867, Sir W. Fothergill Cooke and Sir Charles Wheatstone, F.R.S.
1868, Sir Joseph Whitworth, LL.D., F.R.S.
1869, Baron Justus von Liebig.
1870, Vicomte Ferdinand de Lesseps, Hon. G.C.S.I.
1871, Sir Henry Cole, K.C.B.
1872, Sir Henry Bessemer, F.R.S.
1873, Michel Eugène Chevreul.
1874, Sir C. W. Siemens, D.C.L., F.R.S.
1875, Michel Chevalier.
1876, Sir George B. Airy, K.C.B., F.R.S.
1877, Jean Baptiste Dumas.
1878, Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.
1879, Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.
1880, James Prescott Joule, LL.D., D.C.L., F.R.S.
1881, Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.
1882, Louis Pasteur.
1883, Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.
1884, Captain James Buchanan Eads.
1885, Sir Henry Doulton.
1886, Samuel Cunliffe Lister (afterwards Lord Masham).
1887, HER MAJESTY QUEEN VICTORIA.
1888, Professor Hermann Louis Helmholtz.
1889, John Percy, LL.D., F.R.S.
1890, Sir William Henry Perkin, F.R.S.
1891, Sir Frederick Abel, Bt., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.
1892, Thomas Alva Edison.
1893, Sir John Bennet Lawes, Bt., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.
1894, Sir Joseph (afterwards Lord) Lister, F.R.S.
1895, Sir Isaac Lowthian Bell, Bt., F.R.S.
1896, Professor David Edward Hughes, F.R.S.

1897, George James Symons, F.R.S.
1898, Professor Robert Wilhelm Bunsen, M.D.
1899, Sir William Crookes, O.M., F.R.S.
1900, Henry Wilde, F.R.S.
1901, His Majesty King Edward VII.
1902, Professor Alexander Graham Bell.
1903, Sir Charles Augustus Hartley, K.C.M.G.
1904, Walter Crane.
1905, Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.
1906, Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.
1907, The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.
1908, Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.
1909, Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S.
1910, Madame Curie.
1911, The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.
1912, The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S.
1913, His Majesty King George V.
1914, Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.
1915, Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.
1916, Professor Elias Metchnikoff.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, February 15th, 1917; the Right Hon. Lord Islington, P.C., G.C.M.G., D.S.O., Under-Secretary of State for India, in the chair.

The paper read was—

THE INDIAN SILK INDUSTRY.

By Professor H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.,

Imperial College of Science and Technology, South Kensington.

In the time available to-day it is not possible to deal with an industry so large, so scattered, so varied, as the silk industry in India. In the report prepared by Mr. Ansorge and myself the full details of the industry are recorded, and this report will shortly be available. This afternoon I propose to describe very briefly the general conditions of the industry, to state its extent, and to enable you to see whether India can ever be a large source of supply of silk raw products to this country.

There are in India four kinds of silkworm: that feeding on mulberry, which is the usual silk of commerce; the tasar and muga, wild silks which resemble shantung; and the unique eri, the domesticated castor-feeding silk. Of the mulberry there are two descriptions, the single-brooded race, grown in Kashmir and the Punjab, from French and Italian seed; the many brooded races of Bengal, Mysore, Assam, Burma. Both are reelable and yield two products, raw silk and waste silk; but the quality of the products of the French cocoon is far superior to that of Bengal and Mysore cocoons, and their uses in trade are quite distinct. So are the conditions of their production: the largest industry is concerned with the production of the many-brooded races in Mysore and Bengal; the worms are reared in the people's houses, fed with leaf plucked from the fields; the cocoons are spun on trays and are killed by the sun's heat; the reeling is done on a primitive apparatus over a fire, usually two threads at a time, and yielding an uneven coarse thread, little appreciated outside India. In Mysore the silk produced is woven locally, or in the Madras weaving centres; of the Bengal silk much is used in Bengal, Nagpur, Amritsar, etc., but much is exported, chiefly the product of the filatures of which a few remain, still under the control of a European firm. The Assam and Burma silk is locally used in weaving; it is not a large amount, and is grown wholly for home consumption. This silk is from worms fed entirely on mulberry grown as a field crop as bushes. The superior French race, grown in Kashmir and the Punjab is fed on the leaves of tree-mulberry, and the industry owes its existence to the fact that, in Kashmir, mulberry grows wild all over the valley. There, too, the people grow the worms in their houses; but the cocoons they deliver to the State, and the reeling is wholly done at a central filature. In the Punjab the little silk produced is sold for reeling at Amritsar or sent to Bengal for reeling.

The extent of the mulberry industry can be best shown by figures. These are approximate but not wildly exaggerated (see p. 291).

The silk products are disposed of thus: Mysore, raw silk, one-third to Madras, two-thirds locally woven; waste silk exported to Europe. Madras, raw silk used in Madras, waste silk exported. Bengal, raw silk woven locally and in Bombay cities, Nagpur, Benares, Amritsar, etc. Filature silk exported to France; waste silk spun locally by hand or exported to Europe. Assam and Burma all used locally. Kashmir, nearly all exported to France. Punjab, locally reeled or sold as cocoons for reeling in India.

		Green Cocoons.	Raw Silk.	Rearers.
Mysore	32,000 acres	15,360,000 lb.	1,152,000 lb.	70,000
Madras	12,000 ,,	5,000,000 ,,	400,000 ,,	25,000
Bengal	19,000 ,,	8,000,000 ,,	600,000 ,,	43,000
Assam	Trees	——	12,000 ,,	4,000 families.
Burma	,,	——	15,000 ,,	1,500 ,,
Kashmir	,,	2,640,000 ,,	96,000 ,,	80,000
Punjab	,,	12,000 ,,	1,800 ,,	800

Tasar is wholly a wild insect, which inhabits a great part of the hilly, jungly areas, centring in the great Chota Nagpur and Orissa Forests. In this area it is abundant enough to be worth collecting, and there are classes of people, of hill tribes, who add to their earnings by putting worms out on trees and guarding them. The production is an ancient industry, formerly supplying local needs, furnishing an article for barter with cultivating villages near jungle tracts, who used the silk. And it is an industry that has altered much as the forest areas have been controlled and exploited. As the country opens up the industry naturally declines; the cattle-herds who collect the cocoons, the tribes who rear them, find cultivation or field labour safer and more profitable. The production of tasar is connected with restrictions in food, tobacco and other enjoyments, which are irksome. Disease in the worms is uncontrollable and often disastrous.

So the tasar-producing industry lessens, and will decline unless science can be applied, can combat disease, can make the crop sure and a large one. There are peculiar difficulties, both scientific and other, in this question, and it is not certain that there is justification for the cost of tackling them.

There are no figures of the production of tasar. Wild estimates are possible, and I give you mine, with the proviso that they may be quite double or treble the real figures :—

Muga is a similar insect, feeding on other plants than mulberry, and found only in Assam; it is grown similarly and used similarly. There is little use for it outside Assam, and the bulk is locally used. I can give an estimate of production, partly from the admirable work of Rai Bahadur B. C. Basu :—

Production: 225,000 kahans of 1,280 cocoons each, value Rs. 6,25,000 (£41,500); thread export: 542 maunds of 82 lb., value Rs. 2,16,800 (£13,300); total production: thread, 1,750 maunds; spun thread, 3,000 maunds. Engaged, 15,000 families rearing; 10,000 persons weaving, etc. Total value of exported thread and cloth made, Rs. 14,03,000 (£100,000). Both tasar and muga are peculiar silks, locally reeled by simple processes, and little adapted to export. A French firm for many years reeled tasar and exported it; but they have closed their business. There is a small use of tasar in Cawnpore for making braid for puttees, otherwise tasar and muga are reeled and worn locally, and the waste spun by hand for home weaving.

Lastly, the eri silk cocoon is derived from a domesticated insect, grown in many villages in Assam for local sale and use. The worms feed on castor, the cocoon is unreelable, but is spun by hand for home weaving. Just as in former times flax was spun and woven in Europe, so now, in many houses in Assam, the girls tend the worms, spin the cocoons and weave the cloth for wear, for sale, or for the

	Rearers.	Twisters.	Weavers.	Total.
Chota Nagpur	65,000	20,000	50,000	148,000
C.P.	6,000			
Bengal	5,000			
U.P.	2,000			

250,000 kahans of cocoons (1,280 = 1 kahan).
Value Rs. 1,750,000 = £120,000.

trousseau. There is a surplus, produced mainly by the tribes in the hills, which comes down in barter for cloth, for salt, for rice, and which reaches Gauhati and is sold for export. It is sent to the Continent and is spun, mixed with other silks, wool or other fibres.

The Assam figures of Rai Bahadur B. C. Basu are :—

Cocoons produced	5,325 maunds	
„ exported	1,000 „	Value Rs. 1,08,000 (£7,000).
„ spun	4,325 „	
Thread made	3,150 „	
„ imported	150 „	
„ exported	1,026 „	Value Rs. 2,09,000 (£13,500).
„ woven	2,234 „	
Cloth made		Value Rs. 10,72,000 (£67,000).
		Total Value . . . Rs. 13,89,000 (£86,400).

People engaged probably } 15,000 families in rearing,
5,000 „ in spinning and weaving.

Some years ago the question of eri growing outside Assam was taken up. The industry was started in many parts of India. A mill in Bombay bought cocoons and spun them into yarn, which is still used in Benares and Bhagalpur; but the effort has failed, and eri is now practically confined to Assam as before.

With the many lantern slides which illustrate the production of cocoons and silk, and with the above condensed descriptive matter, you can get some idea of this industry. It is largely a subsidiary industry to cultivation; it is a cottage industry, yielding from ten to three hundred rupees a year to the family who practise it; it engages as rearers and reelers some 400,000 people; it is limited to very definite areas, some of which are decreasing in extent. There are in India some 300 million people, chiefly cultivators; of these one in a thousand adds to his earnings by growing mulberry or castor for feeding silkworms—why do not more do it?

There are definite factors which affect this. They are—climate, custom, prices, disease, ignorance. As regards climate, silkworms, to be profitably grown, must have the right climate; and this climate must persist long enough to feed a brood of worms, say, for two months at a time. In Kashmir they get one crop in May-June; before that it is too cold, after that there is no leaf, and later it gets too cold. In the Punjab there is one crop in February-March; before that it is too cold, after that it is too hot. In Bengal the best crops are in October-November, February-March; at other times it is too cold, too hot, or too moist. So for all India one can determine exactly when conditions are right or wrong, and areas where silk is produced are those where conditions are right.

Secondly, custom—by that I mean the practices of the people, dictated by religion. Many classes will not do silkworm-growing as it entails killing the chrysalides. In Assam and Burma those who do it are generally looked down upon; in the United Provinces, for instance, the largely-predominant Hindu population would not do it. In Travancore, the lower castes and Christians may take to it, but no one else will. Those of you who know India will understand; those who do not must try to realise it. Just as you cannot produce an unlimited amount of long-staple cotton in India because of the insect pests, so you cannot grow unlimited silk because of custom. People in England find it difficult to realise this.

The third factor is price. The silk production of Bengal is probably now less than a tenth of what it was forty years ago, because the prices of rice and jute have gone up steadily, and the price of silk has remained steady or fallen. A pound of silk was equal to 120 seers (220 lb.) of rice thirty years ago, but is only equal to forty now. And as the rearer eats rice he has, wherever possible, abandoned silk: he is better off, and we need not regret him.

Fourthly, there is in all silkworms a disease called pebrine and others called flacherie, grasserie, etc. The first appeared about 1875 in India, and has done great harm; we have treated it on European methods which we now find do not apply in India. Much money has been wasted in Bengal with no effect, and we have now to tackle it properly or see the industry decline.

Lastly, ignorance. There are many places in India where silkworms will grow, but no one knows when or how; but they try, fail and give it up. Many native States have tried and failed; and it is probably only now that we

realise exactly what must first be learnt before we can start growing silkworms in a new area. When we have skilled people who can say exactly when and how silkworms can be grown, then silk will be grown in new areas suited to it.

If you read the detailed report you will understand better; you will better realise the immense difficulties ahead if India's resources in silk are to be developed, and you will understand why the recommendations are what they are. I cannot now discuss these; they are before the Indian Government, and it is not my business to-night to discuss them; but I hope you have a fairly clear picture of what the industry is.

We will now turn to the fascinating aspect of the working up of the silk. It is useless giving word pictures, so I shall rely on slides made from photographs taken in all parts of India last year. First, the raw silk is taken as it is bought in skeins and is opened out; it is then placed over a swift or over two bamboos or three upright rods, and is wound off on to bamboo reels; as the thread passes through the fingers its thickness is estimated and it is sorted into four qualities—the finest goes to one reel, the medium to another, the coarse to a third, the very coarse is rejected. Each quality has its uses, and for this reason the Indian likes and buys coarse Indian or China silk, because in the one skein he gets the qualities he needs for weft and for warp.

Each quality is then tested for its proper use: the warp is usually twisted, first each thread singly, then two together for the best warp. I illustrate a variety of methods by which this is done; they vary in mechanical perfection from the very slow crude single-thread process to the machine doing forty threads at a time. This work is all done by special workers, men or women, in the weavers' quarters or the village.

After twisting comes degumming, dyeing, rewinding and warping. All are done in the houses with simple devices; the warping may be done in the open, on upright sticks, or over pegs on a board, or on a revolving mill from a creel of bobbins. There are all degrees of method. The warp is then laid out, brushed and the healds knitted on by a special worker. In some cases they use eyed healds and the thread is drawn in. The thread is then drawn through the reed, and fixed to the beam of the loom.

Looms vary greatly in type, and there is in India an enormous variety of method, from the simple loom with two shafts to the exceedingly complex *kamkhwáb* loom, weaving elaborate brocades.

The object of the weaver is to secure variety of texture and pattern; he can do this by five methods—actual weaving, *i.e.* methods of so arranging the warp threads that he can produce a texture or pattern; arrangement of differently coloured warp and weft threads, so that he gets a pattern; arrangement of variegated warp or weft threads dyed in sections, giving pattern; additional pattern by embroidery or by shuttle embroidery, as in tapestry weaving; dyeing or printing after weaving. The Indian craftsman uses all five methods separately or together; and there is a very great variety of fabrics produced, from plain white silk to the elaborate and beautiful *kamkhwábs* worn by princes.

It is impossible here to describe the methods used, all contrived with extremely simple devices; the simplest loom has two shafts, two pedals, and pattern is only possible in stripes and checks. Then there is the four or many-shafted loom, weaving twills and twill patterns. In Burma this leads to the eight and twelve-shaft loom doing beautiful fabrics. Then there is the loom with the shafts replaced by cords, and varying combinations of cords worked by strings; there is the Dobbie, used chiefly for borders; and there is the elaborate loom in which each pair or set of threads is connected to a string, and combinations of these are pulled in turn by a boy, who picks them out by means of a series of loops put round each consecutive combination by the loom-setter. This method will give any elaborate combination required; when to it is added the complexity of separate border warps and border shuttles, of separate workers putting in embroidery with shuttles, you get the gorgeous and elaborate *kamkhwáb*.

There are other fabrics made by tying up the warp threads, dyeing the untied parts, and then so arranging them to make patterns; and this is a common device in India. Beyond this are the lovely embroidered fabrics of North India embroidered in floss silk or in heavy thread in a peculiar knot stitch; in these there is great artistic scope and full advantage is taken of it. I show you a few of the fabrics so made, only a very small number that attracted me specially; but the variety of design and texture in India is amazing.

The silk-weaving industry of India is large; it employs probably 200,000 people as weavers and 100,000 as twisters, preparers, etc. In the main the industry exists to supply the silk fabrics of the country, and in this there are

three principal classes—the silk *sari*, *dhoti*, and conventional dress prescribed by custom; the embroidered and fancy silk article mainly made in North India; the fancy silk piece made for wear in Burma, in which variety of design is the essential qualification.

The first is the backbone of the industry. In the Bombay Presidency, Madras, Mysore, Bengal, the Punjab, Nagpur, and Benares there is a weaving industry turning out goods of great value in the conventional garment of the Hindu. This absorbs much Indian silk and more imported silk. The articles are not piece-goods, but complete pieces ready to wear and in all qualities, from silk-bordered cotton to *saris* costing up to £20 a yard. The value of the cloths so produced, taking an average value of cloth as double that of raw silk, is near to £2,500,000; and it is on this demand, little influenced from without, that the industry mainly depends.

There is, secondly, the large trade in fancy silk goods, ribbons, fringes, ornaments, huqa tubes, and embroidered goods, made chiefly in North India. There is no means of estimating even approximately its extent or value.

Thirdly, there is the special market of Burma, which imports yearly raw China silk worth £140,000 and weaves cloth, but it also imports cloth worth £250,000 and wears it. The Burmese are peculiar in that they buy variety, not fixed patterns; they need bright colours, pink, yellow, and mauve in patterns and, above all, variety; so Japan and India export to Burma a great variety of piece-goods which make into *longyis* and *pasos* for daily wear. There is a remarkable industry in Rangoon in printing patterns from wood blocks on Japanese silk; the Burmese in this way get variety at a small cost and can get new patterns printed on whenever they tire of the old.

You will notice that I say nothing of ordinary piece-goods, of plain silks, of tabbys, satins, twills, suitings, spot and stripe silks, lining silks, and so on. There is a production for the big cities, but it is small, and nearly all that is sold is from Japan and China. The Indian craftsman can produce almost anything; in Madras and Burma he is learning new methods and producing new fabrics; but the home demand is so stable, so vast, so near at hand that the trade is mainly concerned with that. The export of Bengal corahs, plain silk woven in the gum from untwisted threads, is nearly dead, and there is not much now produced in India that would interest this country.

Let me now give you some figures, vague, inexact, but perhaps the nearest yet reached. The production of raw silk in India is of an amount near to 2,800,000 lb. of a value of Rs. 17,500,000 (£1,225,000). The export is now small, being that from Kashmir (200,000 lb.) and of Bengal, a very fluctuating amount; I omit eri, tasar, and cocoons entirely. There is a large export of waste silk, from £500,000 to £750,000. There is an import of raw silk totalling over 2,000,000 lb., practically all from China. Silk imported and produced is woven into cloth worth nearly £4,000,000 sterling. These figures are vague and uncertain, but not far out. There are some 370,000 people who rear silkworms and collect cocoons; there are over 250,000 who twist or weave and probably another 100,000 otherwise engaged. There are at least 50,000 persons engaged as dealers or brokers, and there are probably 180,000 looms engaged wholly or partly on silk.

In what relation is this industry going to stand in regard to this country and to the Empire generally? Are the spinning-mills of this country to use Indian waste and eri? Are the weaving-mills to use Indian raw silk? Will England produce and export the spun silk yarn so largely imported by India from Italy and Japan? Will Indian silk goods find a demand in England?

There are two points to bear in mind—the quality of Indian goods and the question of price. I omit the question of a preferential demand for products of the Empire. In business patriotism does not pay, and it is useless to expect India to supply England cheaply or England to pay more than she will, say, to Turkey or Hungary. The quality of Indian raw silk, waste silk, and cocoons is peculiar. The Kashmir is equal to good French or Italian silk and sells well in France, but for the rest Indian raw silk and waste silk is not of a quality suited to all uses.

This can be changed, and even now the new races of silk being grown are approximating to the qualities of France and could be used in England; but it is not as yet clear whether it would be to India's advantage to change quality and seek European markets.

My inquiry was done from the point of view of India, of the Indian silk rearer and silk weaver. I have not looked at the matter from the aspect of the English manufacturer, but if there is a demand for silk raw products from India this can be met, if India be told what is wanted. There is an opportunity now for the

English manufacturer to say plainly what he wants, what he can use, what he will pay. The British Silk Association might play a large part in this development; and, speaking from the Indian point of view, I hope the English user will come forward and help. I would also like to see English spun yarns replacing Japanese and Italian in India, though this hardly seems likely.

If extension of trade with India did occur it must not be supposed that development in India would be quick or easy. There are three great obstacles to development in India, the first being the condition of employment in India, the sweated condition of a great proportion of the workers, the unscrupulous grinding of the craftsman by the employer. Speaking quite generally, with full knowledge of the exceptions, I say that this is the great obstacle to development of any industry or production; and, unless it is tackled rightly, no change will be possible with the opposition of the capitalist and landowner, who desire no change in existing conditions.

The second obstacle is want of enterprise and of business capacity, and the want of ordinary commercial honesty. Very few natives of India will embark on exporting business or have the enterprise to risk their capital; very few will invest money in companies; and this leaves one to the European investor and capitalist. This brings one to the th rd obstacle, the enormous profits required by the European firm or capitalist in India, an amount so large that few industries can meet it. This puts India at once at a disadvantage as against Japan or China. It is well to see this clearly, and to realise that you cannot develop silk in India paying 25 per cent. on capital and be also able to compete with the Japanese or Chinese industry.

These are the great obstacles to any development, and they can be met. But if India is to set out to supply any of the requirements of the Empire there must be some means of knowing what these are; and this must come jointly from India and the Empire. It is perhaps not new to you that the efficient administration of India enables any branch of industry to be rapidly and successfully stimulated, but that is not so in England; and if the British Silk Association or any other body, private or official, wishes to stimulate the production in India of raw silk products or silk goods suited to England, much more must be done than has been hitherto. I wish very much, for India's sake, something real could be done; but I see no likelihood of it unless the conduct of such affairs is very radically changed, or unless some machine is created which does really and effectively bring together the needs of the Mother Country and the resources of this corner of the Empire. Finally, I would like to emphasise the utter neglect of the silk industry in the Empire, in marked contrast to its development by France in her colonial empire. In 1912 I urged the importance of developing a silk industry in the West Indies, climatically the ideal part of the world; but there, as in Africa, in Mauritius, in other parts of the Empire, we have done nothing. Perhaps such a statement is out of pla e to-day when I speak as from India; but the development of a silk industry in all suitable parts of the Empire cannot possibly hurt India, and in the future Empire-grown silk may become so large that the Indian product will be in real demand in this country. I hope this may be so, and I look forward to the time when Britain and the British will develop its silk resources that now remain undeveloped.

DISCUSSION.

THE CHAIRMAN (the Right Hon. Lord Islington, P.C., G.C.M.G., D.S.O.), in opening the discussion, said that the author, in his extremely interesting and fascinating description of the Indian silk industry, had not only shown the advantages that India could offer in regard to its maintenance and extension, but had pointed out the difficulties that must be overcome if that extension was to be realised, especially in the direction of providing raw material for export purposes. He gathered that the advantages to be obtained were very considerable, and also that, whilst the obstacles to be contended with, both physical and material, were formidable, they were by no means insuperable. It was common knowledge to all who were acquainted with the industrial system in India that the important silk industry had of past years retrogressed in some parts of India where formerly it was flourishing. Whilst that retrogression had gone on, the demand for silk throughout the world had steadily increased, and with the retrogression in India there had been a corresponding and conspicuous progress elsewhere, notably in France and Japan. The Government of India, realising the retrogression, and the opportunities that were being taken advantage of by other countries and were being lost by India, looked into the subject in 1915, and came to the conclusion that the best means by which an improvement might be ensured was that a thorough inquiry should be made into the industry as it was established in India. They accordingly very wisely invited the author to undertake the task and to make a report, which

he had already submitted to the Government of India, and which it was at the present time considering. It would be premature for him at the present juncture to divulge the specific recommendations made in that report; but he thought it was clear, from all the author had said in his paper, that if the important silk industry was to be revived and to play the part it should, in view of the natural conditions of India and in accordance with the increasing demand for the manufactured article of silk, it was necessary that very marked improvements on scientific and organised lines should be introduced. It was necessary that appropriate places should be found for establishing the industry; that a suitable and healthy breed of worms for cultivating the raw product should be ensured; that disease should be avoided by every scientific means, and, when present, checked; and that skilled and efficient management should be secured. In short, a general and marked improvement in organisation and in scientific method must be established at every stage of the industry if it was to play its part in India, by an extension on a large scale of export to other parts of the Empire in the years to come, in addition to its indigenous consumption. The author laid stress on the paramount importance, if India was to be regarded as a nursery for an important industry for manufactures in other parts of the Empire, that the producer and the manufacturer should be brought into constant touch with each other. It was essential that the producer in India should know the exact kind and quality that he must produce for the manufacturer to enable him to sell with profit in the outside markets of the world, and some form of co-ordination and organisation as between the producer and the manufacturer must be established for that purpose. He hoped the paper and the author's report to the Government would have the effect of increasing the production of silk in India to a degree far beyond anything that had been the case in the past.

MR. FRANK WARNER (President of the Silk Association of Great Britain and Ireland) said the author had made his audience completely acquainted with the methods of manufacturing silk in India, from the reeling to the final manufacture of fabric, and they were more primitive than he (Mr. Warner) had ever imagined they were. The methods connected with the growing of silk, its spinning, weaving, and dyeing, had vastly improved in every European State, and also in the Far East, particularly in Japan, and in view of what the author had said, and the slides he had shown, it made one feel how almost impossible it was for India to compete in her silk productions with other countries. He fully agreed with the author's statement that the interests of India must be considered first so far as the industry was concerned, and he thought it would be an immense boon to India if her productions were increased to such an extent, particularly of raw silk, that she became an important competitor in the world's markets. So far as climate was concerned, what applied to India in the main did not apply in the northern provinces of India, from which he had seen some very beautiful silk of recent years. Twenty-five years ago practically no silk was grown in Kashmir, although it was well known that Kashmir had been a silk-producing State for hundreds of years. In 1894 a small parcel of silk grown in Kashmir was sent to the India Office, which his father was asked to test, and it proved to be of the highest quality. As a result, the India Office invited Sir Thomas Wardle to go to Kashmir, and to do all that was necessary to start the growth of silk on a large scale. Everyone was very much indebted to Sir Thomas for what he did in that connection, and he also desired to mention Sir George Birdwood, who did excellent work. The export of silk from Kashmir now amounted to about 200,000 lb. annually, compared with practically nothing twenty-five years ago, and the question might naturally be asked, Why should not that increase be very much more multiplied? The quality of thread was finer in size and more even in quality at present than the first parcel sent to this country, but he was not sure that it was of equal strength, or that it had the same vigour and nerve. He believed the first parcel of Kashmir silk was grown from the indigenous worm, and if that was so it behoved those who took practical steps to develop sericulture in India not to cast aside the indigenous worm without giving it a thorough trial. Patiala silk, the first parcel of which came to this country about a year ago and was a very lovely silk, was grown from French seed, and in that connection one very important lesson had been learnt by the Patiala State by the successful growing of silk in Kashmir—namely, when the Patiala State decided to grow silk it engaged the services of a native who had graduated at the French silk school at Montpelier. When he was fully qualified he went to Patiala three years ago and started the industry, which thus began at a very high level of production. If high-grade silks could be grown in Kashmir and Patiala, why should not sericulture be carried on through all the northern States of India with the same measure of success? It was not desirable to bother about the other parts of India where the climate was not suitable, but only those parts which were suited to the growth of silk. The area of those States situated on the foothills of India was double the area of Japan, whose output was now the greatest in the world. Twenty-five years ago the world's production of raw silk was only 13,000,000 kilos, compared with 27,000,000 kilos in 1913, and

even that enormous production was not sufficient for the world's consumption. There was an enormous demand in the world for tasar silk, and it seemed a great pity that India did not hold her own in the growth of it. Eri silk might also be generally grown, not only in India, but in many other parts of the Empire. If, however, India was to compete in the great trade of piece-good production such as in China and Japan, there must be a great development in the present primitive methods of weaving. The British Silk Association, all through its career, had done what it could, not only for sericulture in India, but in other parts of the Empire, and they intended in the future to give their best attention to that part of their policy. They were encouraged to take a deeper interest in the matter because they believed that after the war there would be an Imperial Preference which would bring the Empire together and be the means of developing its resources.

Sir William Duke, K.C.S.I., K.C.I.E., said there was nothing more depressing than to watch the gradual decay of what had been a great industry, and for the greater part of his time in India that was his ill fortune. It was, therefore, with all the greater satisfaction that he heard the hope expressed by the author that the industry might still be revived. Thirty-two years ago the district in Bengal in which he was located was full of traces of an enormous silk industry, which was three parts dead and the other part dying. Two generations before a great commercial house used to lay out annually £80,000 on silk; but the whole of that trade had now gone. A filature which was then run by a European agency on the other side of the district had also gone, and there was now only one English firm which continued to reel silk in an adjoining district. Shortly afterwards the provincial Government took in hand the question of combating one of the great causes of the decay, namely, the pebrine disease; but their efforts failed, owing, he understood, to their attempting to apply it without sufficient scientific knowledge. They attempted to apply the system produced by Pasteur without adapting it to tropical conditions; but he was assured that, if it was properly adapted, Pasteur's system, or something of the kind, would give a supply of pure seed. Without pure seed and the eradication of the disease there was no hope for the industry. With regard to the economic situation, the author had pointed out that the same amount of silk exchanged for only one-third of the amount of rice which it did a generation or two ago. It was obvious under those conditions that a product which had failed to keep pace with the world changes in value must fail. Unless silk could command a better price it was useless to try to re-establish it. He gathered that the silk of which the author was then speaking was the indigenous Bengal silk, which was consumed entirely in India, and which was unsuitable for manufacture in this country. In that connection it occurred to some members of the Government of India that something might be done to improve the value and character of the Indian silk, and that by working on Mendelian lines it might be possible, by successful hybridisation, to get the merits of the valuable uni-voltine Italian silk into the multi-voltine Indian variety. If such a hybrid could be produced, the enormous advantage would be obtained of recurring crops in a climate where crops of silkworms could be reared during a considerable part of the year, and at the same time a silk of high quality. When the author's report was published it would be seen how far that was practicable. If it was practicable he thought the economic question would be solved, because if a silk of equal quality to the Italian silk could be produced it would command a price which would be sufficient inducement to the Indian growers to take it up again. Seven or eight years ago the Agricultural Department in Bengal made efforts to popularise the cultivation of eri silk; but after several years of effort the experiment failed, owing to the want of a market. Failures of that kind could be overcome by a combination of the producers and the manufacturers. Co-operation on the part of the growers alone was not enough; the manufacturers must also take a hand, and the buying organisation must be developed. If it was left to individuals it only resulted in every kind of failure; but a system could be successfully worked by organisation and co-operation as between the producer and the manufacturer.

Sir Louis Dane, G.C.I.E., C.S.I., said it was also his lot, during thirty-seven years' service in India, to see the great silk industry in Kashmir and the Punjab decay; but it was also his good fortune, before he left India, to see it re-established, and to play some small part in its re-establishment. The mulberry grows freely over the greater part of Kashmir and the submontane Punjab, and there was no reason why a large and important silk industry should not be fostered in that part of India; but, unfortunately, in the eighties the worms in Kashmir and the Punjab were attacked by pebrine, and the industry died out completely. Those were the unfortunate days of *laissez-faire*, when it was held that the Government ought not to interfere with private enterprise; but happily that most pernicious doctrine, as applied to India, was now being abandoned, and the Government was trying to do something to help the great industries, which would be the making of India. In 1896, with the able advice of Sir Thomas Wardle, a real attempt to establish the industry was made in Kashmir, where the climate was suitable, and where, in

the second place, the Durbar was sufficiently enlightened to spend some money on the attempt. Up to recent times the Finance Department of the Government of India was only a very closely organised audit department, and did not realise that it was impossible to make money in big industrial enterprises without spending money. Consequently the Government of India could not be induced, without years of effort, to spend anything to encourage an infant industry. Fortunately, in a Native State, if the advisers of the Chief could convince him that their views were sound, money could be found, and that was how the silk industry was really started in Kashmir. The difficulty of the pebrine disease was got over by importing disease-free seed or eggs from France and Italy. The growth of the indigenous worm was encouraged, but it was very difficult to get rid of the pebrine trace at the time, although now a considerable amount of indigenous seed was successfully grown. In 1901, when he was appointed Resident, an audit officer reported that the industry involved a loss and should be abandoned by the State. Happily he was able to get these orders reversed, and the experiment was continued. Without the assistance of the Maharaja and the Durbar it would have been absolutely impossible to have re-established the industry. At first the people were not anxious to take it up, because previously they had not made any profit from it; but in the long run it proved a triumphant success. The Durbar made a profit of £50,000 a year, and between eight and eleven thousand people, who otherwise, owing to the collapse of the shawl trade and the stoppage of grants of rice at favourable rates, would have been in a condition approaching starvation, now received excellent wages in the filatures. The 80,000 silk rearers realised as much for their cocoons as the whole land revenue of the tract. Altogether it had been a splendid thing for the people and for the Durbar, and it was a most happy illustration of what could be done by willingness to spend money on good advice in the starting of a new industry in the East. When he went to the Punjab as Lieutenant-Governor he endeavoured to revive the industry there. He called in the help of the Salvation Army and advised the States to take up silk-growing, and he was glad to hear that the effort made in Patiala had been so successful. Other Native States were taking up the cultivation, and if a certain amount of personal interest was taken in the matter and money was made available, the silk-growing industry in the Punjab had an immense future before it. If, on the other hand, before the industry was well established, the authorities for the time being said that things must be left to the ordinary rule of supply and demand, he was perfectly certain there would be no silk industry anywhere in Northern India. It was necessary to look after such an industry for the first five or six years and spend money on it—even to lose money on it. When the people appreciated there was a living to be made out of it they would take to it, and it would become a most valuable industry. It was a cottage industry which could be done at odd times by the women and children, and that made it all the more valuable. If British India would copy the methods of the Natives States to some extent, so far as they were wise, an immense deal would be done for the industries of India.

MR. A. JOHN SOLLY, representing the silk-spinning industry, said that previous to the war a great deal of silk was purchased from Bulgaria, Thrace, and Turkey, and the silk-spinners of this country desired after the war to replace those silks with silks grown within the Empire or by our Allies. For the growth of silk good climate and cheap labour were required. It was largely grown in Italy, France, and the Levant, and if the Italians could make a living out of it the Indians ought to be able to make fortunes. There was something radically wrong if Indians could not live by growing silk when Italians and Frenchmen could do so. His greatest hope lay in the awakening of the Government to its responsibilities in the matter, and also to an awakening of the people in India itself. He hoped there would be a great development in the future through the co-operation of the Government and the commercial classes, and by the education of the inhabitants of the distant countries in which silk was grown.

COLONEL C. E. YATE, C.S.I., C.M.G., M.P., emphasised the necessity of the silk industry being stimulated in India if it was to be successful. When he was Chief Commissioner of Baluchistan he did his best to help to stimulate the industry inaugurated by Colonel Showers in Kalat, and excellent silk was produced; but directly the stimulus was withdrawn the industry died down. The want of enterprise and business capacity among many of the natives, as stated by the author, was undoubtedly one of the reasons the silk industry in India did not flourish. He hoped that the Chairman would see that the industry was stimulated in every possible way, and he looked forward to the inquiries that were now being made at the Imperial Institute with very great hopes for the future.

SIR FREDERICK A. ROBERTSON, LL.D., in moving a hearty vote of thanks to the author for his interesting and instructive paper, said that Government help was very useful to such an industry as the silk industry, and it was worth while risking some money with the object of seeing whether it was one which the natives of India ought to be encouraged to pursue; but it was exceedingly dangerous to

press an unsuitable industry for which there was not a proper market. Although, therefore, he approved of Government help being given, he thought it should be very carefully watched. It might be the case that the Bengali knew a great deal better than the European when he gave up the cultivation of silk for rice; and if by growing rice he could make four times as much money as by growing silk, it would be a very bad thing to try to force him to grow silk. With regard to the question of the Native States having shown more enterprise in the starting of the silk industry, it must be remembered that they were in a position to apply an amount of pressure which no British Government could. The silk industry was, no doubt, paying in the particular district in which he had seen it, but whom was it paying? He thought some of those who had spoken had lost sight of the fact that the silk industry in Native States looked well on the surface, but that it could only be pushed with great care in India. It was only in those parts of India in which there were signs, not merely produced by official or governmental pressure, but signs coming from the outside commercial world that there was a demand, that the industry would pay. Encouragement and financial support in its initial stages were desirable; undue pressure was not. It was clear that the author and the Government fully shared these views, and this was the greatest encouragement to the hope that a successful silk industry might be established on sound lines.

MR. W. COLDSTREAM, I.C.S. (retired), seconded the motion, which was carried unanimously.

PROFESSOR H. MAXWELL-LEFROY, after thanking the audience for the cordiality with which they had passed the resolution and Lord Islington for his kindness in presiding over the meeting, said that those present had been more or less led to hope that other parts of India could rival Kashmir in its production of silk; but it must be borne in mind that in exactly the same time in which the Native State had built up its silk industry, in the British district bordering on Jammu, although it was larger than Jammu, the silk industry there was ten times less in extent than in Jammu. It was no good blinking the fact that the reason for that was that methods were used in the Native States which could not be applied in the British district. There were at the present time eighty thousand rearers in Kashmir who were satisfied and who liked the industry; but it must not be forgotten that they were paid only one-third of the market value of the cocoons, and the difficulty had arisen that a native who could smuggle his cocoons over the frontier obtained three times the price for them that he did in his own State. It was impossible to adopt Kashmir methods in British India, and he therefore did not wish the audience to go away with the idea that a large industry could be developed in India on the lines of Kashmir. Sir Louis Dane had referred to the indigenous Kashmir worm. The worm that was now being reared in Kashmir was not the original indigenous worm produced in Kashmir, but was produced from French stock. The original indigenous Kashmir worm was so nearly extinct that they had not been able to get any, but they were trying to do so.

MR. WILLIAM COLDSTREAM, I.C.S. (retired), writes :—At the conclusion of Professor Maxwell-Lefroy's paper on Indian silk I mentioned that I had conducted a series of experiments in the domestication of tasar silk in the Punjab. My experiments were reported officially at the time. (See the Agricultural and Horticultural Society's *Journal*, Calcutta, Vol. IX. Part I.) From 1876 to 1881, when Deputy Commissioner of Hoshiarpur District (in 1880 at Lahore), Punjab, I attempted to domesticate the ***Antheræa sivalica.*** I collected the wild cocoons from the villages, and kept them in bamboo cages till they were ready to burst. The moths hatched out in June or July at the beginning of the rains. The eggs obtained were placed in flat basket trays, and the worms were, when a few days old, placed out in the open on beri trees (*Zizyphus jujuba*). An attempt to feed them by hand ended in failure. The beri proved to be excellently suited for the purpose, as, after its leaves had been browsed down by the worms, it sent forth in a few days an abundant flush of fresh leaves. The Sáwani plant (*Lagerstrœmia Indica*) was also tried, but with less success. The beri is evidently the Punjab leaf for the tasar worm. The worms browsing on the tree in the open arrive at full growth in twenty-five to forty days, and forthwith begin to spin. I planted close to my house, at Hoshiarpur, a little grove of *beris*, the trees only a few yards apart. They established themselves easily, and in three or four years were ready as feeding-grounds for the worms, some of them reaching by that time a height of ten to twelve feet, and becoming quite well developed. In the Punjab, groves of grafted or Kabuli *bers* are very common. The trees spread thick and low, with long pendulous branches arching over to the ground, and thickly covered with leaves. Such groves could, I believe, most easily be converted into tasar plantations. The trees are not high, so that the watcher's task would be easy, and the supply of succulent leaf is abundant; and as the *beri* crop is over early in the year, the trees serving in autumn as pasture ground for tasar worms would not, I believe, impair their fruit-producing powers. Several hundred worms on a tree soon strip it of its leaves, for the worms are very voracious, and when full grown are some five to four inches

long. I have taken more than two hundred cocoons raised on one of my own little beri trees. Though the reeling of tasar is usually considered to be somewhat difficult, I found little trouble in reeling off the silk from the cocoon. I got for the work one of the silk-weavers from the neighbouring district of Gurdaspur. He reeled off a clean lustrous thread of four strands, keeping four cocoons bobbing in a dish of boiling or very hot water in front of him. I do not believe he used potash or anything but the hot water to dissolve the natural cement. The man worked at the rate of about fifty cocoons per diem, yielding about two and a half *tolahs* of silk. Beautiful tasar wool or floss was also turned out, the cocoons being teased, not reeled out. This tasar was clean, soft, and elastic, like cotton-wool. On the whole, though I cannot say I have absolutely ascertained the conditions of success, I have seen so much in the course of my experiments as to make me believe it possible that a kind of cottage industry of rearing tasar, requiring absolutely no capital, and capable of being conducted by women and children, may some day arise, if pains are taken by experiment and the offer of rewards to ascertain these conditions and to introduce the industry to the notice of the natives. The wild tribes of Central India rear the cocoons; why should not the cottagers in the Punjab hills? The insect is indigenous in both places, and its food can be provided to any extent by planting at almost no cost. "One great objection," says Sir George Watt, "to the development of the tasar silk industry is the imperfect and faulty system of Indian reeling. This fact is at once established by the published figures of the tasar reeled fibre, the Italian or improved fibre yielding three or four times the price of the ordinary native-reeled silk" ("Dicty. Economic Products," Vol. VI. Part III. p. 151). It has been suggested (see Hailey's "Monograph on the Silk Industry of the Punjab, 1899") that the ease with which my silk was reeled might perhaps be accepted as an indication that the *Antheræa sivalica* would yield good results under the improved reeling process, and that it would be at all events interesting to ascertain whether this were or were not the case. It has been considered a matter for regret that no successor carried on my efforts to cultivate the *Antheræa sivalica*. My attempts at Hoshiarpur came to an end when I left the district. The little grove of beri trees planted near my house to supply food for the worms was cut down by the owner on my transfer (District Report, 1899).

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 7th, 1917; EDWARD DENT, M.A., Member of the Council, in the chair.

The following candidate was proposed for election as a Fellow of the Society:—

Ledgard, Sir Henry, Langdale, Farnham, Surrey.

The following candidate was balloted for and duly elected a Fellow of the Society:—

Willis, Henry S., Weardale House, Wearhead, Co. Durham;

and as an Honorary Corresponding Fellow:—

Belaiew, Colonel Nicholas T., C.B., Chemical Laboratory, Michael Artillery Academy, Petrograd, Russia.

The paper read was—

GERMAN METHODS.

By JAMES HARRIS VICKERY, LL.B.

It is not intended in this paper to attempt anything like an exhaustive treatment of the vast subject of German methods. It would require a specialist in each of the subjects to accomplish that task. It is only intended to give occasional glimpses at these methods as they have appeared to me from time to time during a professional residence in that country extending over a number of years.

I.—DIPLOMATIC.

My first experiences of Germany may not be without some interest, since they refer to a period during which other countries, some of whom are now belligerent and some neutral, were then at war. Shortly after my arrival, in the summer of 1897, the Spanish-American War broke out, and I was able to observe the conduct of Germany in the *rôle* of a neutral professing friendship for both belligerents.

The salient feature of the German attitude, more especially of the commercial and industrial classes and of the people at large, was hostility to the United States. This was an interesting revelation. Tangible reasons for this hostility did not appear to exist. The official attitude was correct. But the spirit of envy and enmity seemed to permeate the very atmosphere; it cropped up continually in private conversation, and found daily expression in the newspapers of the metropolis; indeed, the German newspapers of that day seemed to vie with each other in the art of garbling and mutilating news of the conflict so as to create popular "Stimmung" or feeling in favour of Spain and against the ever-growing Republic of the New World.

It was, in fact, my first experience of that particular kind of joy which the Germans themselves so appropriately term "Schadenfreude," which may best be translated as "pleasure in the discomfiture of another."

Such was the political atmosphere in Germany when the news came of the action of Admiral Dewey in Manila Harbour, and reports began to be flashed over the world that it would probably have come to a conflict between the American Admiral Dewey and the German Admiral Diedrichs had it not been for the fact that there were certain British battleships in the vicinity with decks cleared for action, which exercised a restraining influence on the meddlesome tendencies of the German admiral.

Boer War.

Two years later the Boer War broke out. Again Germany played the *rôle* of a professed neutral, but it was obvious, from the very first, that the feelings of hostility engendered by this conflict were much more intense than in the case of the Spanish-American War. In fact it was evident from the beginning that practically all classes of Germans appeared to have been holding in reserve a reservoir of hatred of Great Britain. There is no purpose in going further into this matter, which is now ancient history, and I only refer to it because it constitutes a further example of German conduct as a neutral, the outstanding feature being that, although the war was no concern of hers whatever, and although one would naturally have looked for a lofty, philosophical and judicial attitude at least on the part of her eminent professors and publicists in dealing with the questions to which it gave rise, these same professors and publicists, the daily press, and even the more serious scientific and learned organs, all contrived in one way or another to sink to an extraordinarily low level of partisanship, characterised more by enmity to Britain than by friendship to the Boer Republic. I remember especially a petition signed by some seventy university professors which was circulated at the time and which, in its purported statement of fact, contained a veritable travesty of the real causes of the conflict such as I had thus far not seen elsewhere.

Peace Conference, 1899.

If the conduct of the German professors and savants, and of the German people in general, was a big disillusionment to one who had been taught to regard this nation as possessing almost more than the usual sterling virtues, the conduct of official Germany at the first Peace Conference at the Hague in 1899 was calculated to complete the evidence of what was and is an undoubted fact—namely, that there has long existed a vast chasm between the political ideals of the German and English speaking races.

I am only referring to the first Peace Conference for the purpose of pointing to one episode illustrative of German diplomatic methods. It is rendered all the more interesting on account of the recent peace overtures of Germany and of the "Peace without Victory" speech by President Wilson which has been variously, and to some extent unfavourably, interpreted in the Entente press. The episode to which I am about to refer has not, so far as I am aware, been made public and belongs perhaps to the secret history of the Conference.

When, in obedience to the Czar's rescript, representatives of the nations gathered at The Hague to deliberate on the subject of disarmament, etc., it was immediately realised by the British and American representatives that the Conference would be a fiasco if it did not devote its attention to other questions more ripe for solution than that of disarmament.

The British and American representatives decided that, before there could be talk of disarmament, some practical effort should be made to dispose of international disputes by processes more nearly akin to those practised in courts of law and boards of arbitration—in short, that an attempt should be made to establish the beginnings of a real international law to be administered by a real international court. The French delegates heartily supported the project. The late Lord Pauncefote, as head of the British Delegation, took the initiative in the drafting of the scheme; Dr. Andrew D. White, as head of the American Commission, devoted his great influence and talents towards tempering the scheme to the circumstances of the New World. Prince Münster, as head of the German Commission, brusquely refused to support it, or to co-operate in any way in the matter. He regarded it as contrary to German interests and as an infringement upon diplomatic prerogative. All efforts to bring him to reason failed; all representations to the effect that he was planting himself squarely across the current of peace tendencies of other leading nations were in vain; he remained hostile and obdurate. Realising that it would probably be impossible to achieve any useful result in the face of the continued hostility of the German representative, Dr. White wrote an impressive and urgent letter to the German Foreign Secretary and delegated another member of the Commission to present this letter in person, and to make it plain to the German Foreign Secretary that, if the earnest efforts of the Conference to accomplish any useful work in the direction of diminishing the cause of war

and furthering the interests of peace should be frustrated by the German representative, the whole Conference would be a fiasco, and the other nations would hold Germany responsible for having wilfully wrecked it.

As a result Count Münster was finally instructed to withdraw his opposition. The other nations, under the leadership of the British, American and French representatives, completed the work which resulted in the establishment of the Tribunal of The Hague—an institution which one day may well fulfil the hopes of those who laboured to establish it. In any event it will remain as an outstanding fact of the history of those days that "peace-loving" Germany unmistakably revealed herself at that Conference as a determined opponent of every attempt to provide a peaceful solution of international difficulties by means of a tribunal or by arbitration.

It would be a grave mistake to assume that President Wilson was unaware of this fact when he recently declared in substance that the aspirations and peace aims of the two groups of belligerents, as respectively enunciated by their own statesmen to their own nations and to neutrals, appeared to be the same. President Wilson was doubtless well acquainted with the despatches on file in the State Department from the American Commission—which, by the way, contained two brother university presidents—and well knew that America and Britain not only *professed* their adherence to the cause of peace, but *worked* in harmony with those professions to establish the International Tribunal and to further the cause of arbitration; while Germany, although likewise professing her love of peace, refused her co-operation as regards the project to establish the tribunal and opposed arbitration.

In the light of these facts, President Wilson's recent utterance takes on a new meaning and significance as to the manifest inconsistency of German professions and practices. President Wilson's peculiar phraseology will, it is hoped, not have escaped the attention of the German Foreign Office, for, in the light of the developments of the last twenty years, it is susceptible of no other meaning than that of a delicately veiled challenge to Germany to bring her practices into harmony with her professions.

Relations with Canada.

Another minor diplomatic episode may not be without interest at the present time. As is well known, when Canada devised a tariff based upon reciprocity to the benefits of which England, by reason of her free trade policy, automatically became entitled, Germany sought and insisted upon having a like advantage in the Canadian market, on the ground of the most favoured nation arrangements. Canada replied that Germany could have the same treatment as England if she in turn granted the same treatment to Canada as England. The question was, therefore, one between treaty rights irrespective of reciprocity (which was Germany's contention), and reciprocity as a consideration for preferential treatment (which was the Canadian contention). As Canada insisted on maintaining her policy, the most favoured nation arrangements were terminated by England at Canada's request. Such open evidence of the tendency of Motherland and Colony to draw closer together was regarded in Germany as little short of a crime, and Germany promptly commenced the now familiar process of strafing the culprit. Extra duties were placed upon Canadian products. Canada promptly replied by imposing a surtax on German products. As a result of these measures of reprisal German-Canadian trade diminished almost to the vanishing point, while Anglo-Canadian trade and commerce between Canada and the Republic to the south continued to grow in ever increasing volume. After a number of years it dawned upon the German mind that the process of strafing Canada had only resulted in depriving the Germans themselves of the Canadian market, to the not inconsiderable advantage of British and especially of American manufacturers.

Proposals were then made through the German Consul-General in Montreal to the Canadian Government, which resulted in the mutual removal of the prohibitive surtaxes, and established favourable reciprocal treatment with reference to a number of specific commodities and products of either country.

Canada thereupon sent a special Trade Commissioner to take up his residence in Germany, and there to look after the commercial interests of Canada, as German interests were being looked after by the German Consuls in Canada. One would have thought that the Germans would naturally have seized this opportunity of expressing their goodwill and satisfaction at the inauguration of a new era of friendly commerce, and that they would have shown this first Canadian Trade Commissioner to Germany similar attention and courtesies to those which had been constantly shown to German Consuls in all parts of the Dominion

Nothing of the kind happened. The Canadian official was required to present himself to the police for registration, which he did. Presently, after he had taken an office in one of Berlin's leading streets, he was presented with a form and required, within such and such a time, to make a return of his property and income for the purpose of taxation. The Canadian Commissioner replied in substance that, inasmuch as his position was analogous to that of a Consul, he hoped that the same courtesy would be extended to him as was enjoyed by the German Consuls in Canada. The Germans replied that he was not a Consul, and that he must declare his income for taxation, otherwise he would be strafed. A number of communications passed, in which the Canadian Commissioner was at pains to point out his inability to comply with the German demand without the sanction and instructions of his Government, and also that to transmit the German demand to his Government would produce an unpleasant impression and tend in some measure to undo the work of reconciliation so happily begun.

The Germans remained obdurate. Finally, the Canadian Commissioner informed them that he refused to make any return unless and until instructed by his Government, and that if any attempt were made to assess him and to collect the tax by force as they had threatened he would close the office and leave the Empire. This was in effect an ultimatum. In the sequel the Germans ungracefully retreated, and without a line of regret or apology informed the Commissioner that it would not be necessary for him to make a return of his income.

The episode is of no consequence in itself, but it is one of the numerous unpublished examples of German blundering and boorishness in dealing with other peoples—a method of official conduct which is characterised by want of consideration, and by inability to appreciate the bad impression produced on others by the blind and clumsy insistence upon German rights and German rules as a sort of standard to which all must bow down irrespective of the equities of the case or of the psychology of the parties.

II.—Education and Science.

Much has been said and written about German educational methods. I shall not attempt to go at length into this much traversed subject, but one or two points deserve more consideration than are generally given to them.

A few years ago one of the American Exchange professors, during his sojourn in the German capital, gave a lecture on the subject of educational methods. He pointed out to his hearers some essential differences between German, British, and American universities as they appeared to him. The British universities, he said, still continue to exercise a strong parental influence over the students and to devote much attention to the process of character building, to which process the extensive sport activities of the British students made a not inconsiderable contribution. In Germany, the student was left largely to his own devices in private life, but the scientific instruction available to him was ahead of that afforded by the British institutions. This difference was mirrored in the very words of the two languages. The British *educated*, the Germans *instructed*. The word "Unterricht" *did not* mean nearly the same thing as education, and he pointed out that the better American universities sought both to educate and to instruct, in order that character might not be sacrificed to knowledge.

This has always seemed to me to embody an essential truth. The evil reputation of the Germany of to-day is not due to any want of knowledge but to a want of character, and in the long run character will prove to be the more valuable of the two attributes.

Another difference of great importance may be here referred to—indeed, it cannot be too often referred to, because it is one point upon which we have been most remiss. I refer to the intimate connection between scientific teaching and research and the commerce and industry of the country. It is the habit of the Germans to refer to the English as being a "practical" people. In point of fact the German has been much more practical in the matter of turning scientific knowledge to account. With all his boasted idealism he has long since ceased to follow scientific research purely and solely for the love of the thing; he has been reared in a frugal, economic world, and has been taught that if science possesses any practical value it would be an unpardonable violation of an economic law to allow that value to go unexploited. As a result the university and Government laboratories are closely linked up with the factories and workshops of the nation. The industrial and commercial value of science and the Imperial recognition of the indispensable character of the scientist have had the effect of elevating scientific achievement both in theory and in practice to a position relatively higher than in any other country. The avenues by which scientific knowledge and discoveries are

transmitted from the universities and laboratories to the centres of industry, there to be practically applied and commercially exploited, have not lowered the tone of the scientist, but raised the tone of the industries.

It is impossible within such small compass to go into the details of the German system of education, the study of languages, the technical and commercial colleges, the continuation schools, and the like. These are details. I am more concerned with the spirit behind this development.

A few years ago the late Joseph Chamberlain asked us to *think imperially.* We have commenced to do so. In Germany not merely one man as a voice crying in the wilderness, but a thousand voices, from the Kaiser downwards, have been crying in chorus—*think scientifically, act scientifically.* This high patronage of science has been largely instrumental in breaking down the absurd old class distinctions between the professions and the trades. The idea that a lawyer or a doctor stood upon a higher plane than a mere business man never did have any justification either in theory or fact in a properly constituted social state. Ordinary commercial pursuits were mistakenly regarded as entirely outside the field of science, and even though the industries might lay hold upon this or that scientific truth or discovery and commercially exploit it, that did not justify the industrialist in regarding himself as being upon the same high plane as the professional man. This idea was inevitable so long as the scientific field remained restricted to pure science, to science for its own sake as a complete end in itself. But when it was realised that science could only be fructified for the benefit and uplifting of the human race being *practically applied* in all branches of human activity, in commerce and industry as well as in law and medicine, science itself became united and expanded into connected theory and practice with the result that, instead of being debased through its practical connection with commerce and industry, the latter were elevated to a scientific plane as high and as meritorious as that of the so-called professions.

This, I submit, is the essential truth of the matter. We in this country are now recognising that truth and putting it into practice. There is no need of our copying German methods, for if we once recognise the underlying truths of scientific development, both in theory and practice, we shall be able to work out the methods of fruitfully applying the discoveries of science and to devise the means whereby the trader and the industrialist may be elevated to honourable recognition.

III.—Social.

Certain social institutions in Germany have long deserved greater attention than they have received at our hands. Those to which I am now about to allude belong to what may be called *stock-taking processes*, and they constitute a most important factor in that science of organisation of which the Germans claim to be masters.

The foreigner visiting Germany, either for purposes of pleasure or of business, who has found it advisable to go into lodgings or take a flat, has usually been disagreeably surprised to receive a visit from the police with a request to present himself forthwith at the police-station. This is popularly attributed to some special desire on the part of the German authorities to exercise more than the usual degree of watchfulness concerning all foreigners within the Empire as a measure of political and military safety. That is undoubtedly one of the objects so far as foreigners are concerned, but its main purpose is to see that the process of stock-taking is duly and thoroughly carried out even in the case of foreigners. These stock-taking processes apply equally to all persons, whether subjects or foreigners; only the extent and kind of such stock-taking is varied according to the circumstances. Thus, there are three processes of registration.

1. *Civil Registration*, which applies to subjects and foreigners alike.

2. *Business Registration*, which requires that all persons, firms and corporations doing business in Germany, or coming under the definition of *merchant*, shall be properly registered in the business register which is kept by the local or district court having jurisdiction in accordance with the provisions of the commercial code. This business register is divided into different divisions according to the nature of the person, firm or company to be registered. The stock companies, the limited companies, the societies in commendam, partnerships and individuals, whether doing business in their own name or under some other style and firm, are required thus to register. No distinction is made in this respect between German subjects and foreigners, excepting that in the cases of German branches or foreign concerns special items of information

concerning the constitution of the foreign concern are called for in addition.

In the register itself, provision is made for special entries to show names and addresses of the proprietors of individual firms and partnerships, and in the case of companies the names and addresses of the directors, supervisors and managers, and in all cases firms are required to file a statement accompanied by specimen signatures showing the person or persons who are entitled according to law and according to the articles of the partnership or company to sign the firm or corporate name with binding legal effect. Changes in ownership, in boards of directors, supervisors, and managers, are chronologically recorded. The register is open to public inspection and certified. An abstract of the entries can at all times be had on application on payment of the folio fees which, in the average, amount to between 6*d.* and 1*s.* Under this system partners can be sued in the partnership name, and the certified abstract from the business register is evidence of the constitution of the partnership.

I could give many other instances of the utility of this register, but the main point to be kept in mind is that it furnishes a uniform and complete registration of all persons, concerns, and corporations engaged in commerce and industry in the Empire. It thus constitutes a register which, by way of comparison, would represent more than a combination of the Companies Register at Somerset House and the new register to be kept under the recent Business Names Act, because it also includes all individuals and partnerships doing business in their own names.

3. *Service Registers.* — Then there are the special military and naval registers, which are a strictly militant institution. In these are recorded down to the last detail the personal histories of all those belonging to the army and navy. In a sense these service registers are based upon the civil register, because the latter furnishes the necessary data according to which the military and naval authorities keep track of those young men approaching service age. Thus the civilian register and the military and naval registers contain at all times, both in peace and war, an exhaustive statistical statement of the man power and capacity of the Empire. Moreover, these registers require that, instead of merely general indications of trades, professions, and the like, the persons subject to registration shall state explicitly their particular trade, profession, or calling. Thus, the general term "engineer" is not sufficient; the specific kind of engineer must be given in detail. These registers, therefore, may also be said to contain continually up-to-date statistics of the brain power of the nation.

Census.—Another form of stock-taking is that of the census. The complete civilian register of men, women, and children within the Empire, with their exact addresses, and with the compulsory entry of all changes of address, makes it possible with a minimum of cost and delay to distribute the necessary census forms to be filled up on the date appointed for the actual taking of the census. The legal obligations imposed on the subject to assist and co-operate in the taking of the census are cumulative. A householder, *e.g.*, is required to see that all persons comprised in his immediate family as well as all persons in residence in the building of which he is the owner or proprietor shall properly fill in the returns.

As a result of this system the taking of the complete census of the Empire is accomplished in a period of twenty-four hours, and during that period every person is required to make the return, no matter where he may be, whether in a hotel, in a railway carriage, in ships at sea, or at work in the fields and mines.

As a recent example of the value of complete registration during the war, I would mention that the German Imperial Gazette, towards the end of last year, contained a proclamation requiring a complete census of the nation to be taken in the twenty-four hours between November 30th and December 1st, 1916, and the forms, which had been previously distributed on the basis of the civilian register, were accompanied by additional forms calling for a complete enumeration of horses, cattle, sheep, goats, and other animals, and of all geese, ducks, turkeys, and poultry belonging to the individual subjects of the Empire. I believe that this is the first time in the history of human institutions that a complete census of man, woman, beast, and bird in an Empire of nearly seventy million inhabitants has been accomplished in the incredibly short space of twenty-four hours and without the devising of any special machinery for that purpose beyond the ordinary functions of the police with the co-operation of the subjects themselves.

Compared with this example of scientific stock-taking, I fear that most of us must concede the fact that the National Registration Act of 1915 is but a poor example of British administrative thoroughness.

I ought not to close my reference to this subject without pointing out that the civilian register is of the utmost value as a means of controlling the administration of the income tax and other tax laws. Every person is required to make a tax return. Some do not do so, but those who do not are assessed and lose the right of appeal. None escape, because the completeness of the civilian register makes it possible to assess all those who have failed to make the declaration required by law.

To give one example of the thoroughness with which the tax-paying capacity of the people is exploited, it may be pointed out that prior to the war there were several hundreds, perhaps even thousands, of English goverresses in various parts of Germany. Their annual incomes on the average would be about £40 to £50, or 800 to 1,000 Marks. Incomes up to 900 Marks were exempt, but the German tax officials reasoned thus: These English girls get free board and lodging in well-to-do and rich families, the value of which would amount on the average to another £50 per year, equals £90 to £100; deduct the exemption of £45, and there remains a taxable income of £55. In this way these poor English girls have for years been required to contribute twenty Marks per year towards the Imperial revenues. If the many thousands of Germans and other foreigners who have resided in this United Kingdom year after year had been as thoroughly card-indexed and taxed, a very considerable amount would have been secured for the British Treasury.

There is still one other point in connection with this stock-taking process which is of great importance—first, collectively, in determining the man capacity of the nation, and, individually, in forming an estimate of the character and ability of the individual, and that is the custom of issuing certificates and testimonials covering the school period of the German youth and their subsequent business activities. These papers are collectively known as "Zeugnisse," or testimonials. A boy or man seeks employment; his first step is to produce his papers which show what education he has received, what technical instruction he may have had, the character of his conduct, the situations which he has occupied, the satisfaction which he has given; in brief, whether young or old, his "successes in life," and, frequently read between the lines, also his failures in life. A man seeking employment without the corroborative evidence of such papers is lost, figuratively speaking. These papers constitute his recorded self; if he is not on record, he practically does not exist. Thus, a poor person seeking to enforce some right at law, and claiming the advantage of the provisions for suing *in forma pauperis*, is required to produce an official certificate of good character, and such certificate is based, not upon the testimony of friends and relatives, but upon his recorded history in the custody of the authorities, and if that record is not good, the courts may deny him the advantages of legal aid.

IV.—German Industrial Syndicates.

It is not my intention to attempt anything like a detailed description of the German industrial syndicates. Professor Macgregor has already dealt with that subject in a most admirable and lucid manner. There are, however, certain phases of that question which possess for us a peculiar interest at the present time, when sovereign necessity is forcing us, as we have never been forced before, not only to work, but to do so subject to strict governmental regulations. We are, at the moment, a Socialist State, conducting many nationalised industries, and it is altogether likely that certain principles and practices of paternalism in government will remain permanently as a result of the war.

The main difference between British and German industrial syndicates consists in the fact that, generally speaking, the basis of the one was *capital*, that of the other was *output*. The same is true of the American trusts. In the popular mind, trusts and combines are synonymous with money power. Both in Britain and in America the freest possible scope is given to individual initiative; while, on the other hand, the governments have hitherto not developed greatly in the direction of nationalising industry. Quite the opposite is true of Germany, where the principle of nationalisation has been applied to a much greater extent. Now it is obvious that the more the industrial field is invaded by the State the smaller will be the remaining extent of territory open to exploitation by private enterprise. Consider for a moment what would be the difference between, *e.g.*, the Standard Oil Company with and without railways. Railways are privately owned in America and nationalised in Germany. A capitalist group can secure the control of a privately-owned railway and, although it is a public-service company, it can nevertheless in a thousand ways be so administered as to favour the primary objects of the controlling capitalists. In Germany that is impossible. Where private companies perform public services.

there is always a potential danger of their being diverted from considerations of public welfare to considerations of private interest and advantage, even under systems of strict control.

The point which I wish to emphasise is, that there are three relationships between the State and the subject: (1) Parental control, or that which is exercised from above; (2) competitive control, or that which is exercised laterally; (3) partnership control, or that which is exercised from the *inside*. In America, where there are very few nationalised industries and great individual initiative controlling vast sums of capital, the tendency to abuse the almost limitless opportunities for industrial combination and for the use of capital called for corrective measures, which were, in fact, devised and applied from above in the shape of the Sherman Anti-Trust Act, according to which any industrial combination falling within the definition of the Act could be regarded as a plot or conspiracy against the commonwealth.

In Germany the State itself is an *industrialist*. It runs the railways and canals, the letter post, the parcels post, the collect-on-delivery system in connection with the above, and the post-cheque system of banking, the telegraphs and telephones. It also controls the Imperial Bank as the institution governing the money market by means of its so-called "Bankpolitik," or monetary policy, which it formulates and administers. In the important domains of transport and banking the State thus occupies a position in some cases equivalent to that of a *competitive industrialist*, and is therefore able largely to influence the policy and practice of the industrial syndicates or cartels in the direction of the national interests.

Where there are Government-owned and controlled works in various branches of industry there exists a direct lateral control through competition, and, since the Government itself is frequently the chief consumer, the competing private industries find it more to their advantage to retain the goodwill of the Government as a customer than to incur its displeasure as a competitor. We can see these processes in operation in our own country at the present moment. The British Government has become an industrialist, and is manufacturing all kinds of munitions of war; but it also takes the output of private concerns. It is therefore in a position to know what the product ought reasonably to cost, and, in the event of inflated prices, to exert a corrective influence.

In my opinion the most interesting and effective form of control by the State over the larger industrial syndicates and cartels is that which may be described as *partnership control*. The German company laws, especially the comparatively new law known as the Limited Company Act, are based upon the principle of freedom of contract ("Vertragsfreiheit"), and hence individuals, partnerships, joint-stock and other companies, may become members of a new company by executing the contract of association. Many of the German syndicates are formed under this special Limited Company Act, which provides for a very elastic constitution that may at will be made as simple as a partnership agreement or as complex as the joint-stock company. The purpose of such a syndicate is to apportion the voting power in accordance with the turnover. Every individual, firm, partnership, or company, through membership, acquires a corresponding *voice* in the new company, so that the company in general meeting represents an *industrial assembly* in respect of the industry in question, or of so much of it as they collectively represent. If the Government is engaged in the conduct of works in that industry, it may either remain an outsider, and therefore a competitor in the ordinary sense, or it may come into the syndicate and thereby become a *partner* in the common undertakings and objects. As such, it naturally takes part in all the deliberations and in all the measures devised to determine and fix prices and regulate output.

There are other cases where the Government was deeply interested in the output of a syndicate, as, *e.g.*, where the Government was the chief buyer, and as such might be unwilling either for political or other reasons to pay the syndicate price. In such cases the Government frequently nominated a Commissioner to sit on the Board of the syndicate for the express purpose of watching the Government's interests as buyer, and securing preferential treatment in the national interests. In still other cases, the Government Commissioner was delegated to watch foreign competition and to study and even supervise the various forms and methods resorted to for dumping surplus products on foreign markets.

The above and various other phases of the political situation and industrial development serve to explain why it is that, notwithstanding the vast extent of the syndication of the industries in Germany, it has not been found necessary to pass special acts or resort to other

forms of exceptional legislation, similar to the Sherman Anti-Trust Act in America, in order to prevent the unrestrained syndication of industries from developing into intolerable evils, endangering both the national welfare and individual freedom.

It has long been recognised in Germany that the syndication of industry is in itself a perfectly legitimate and legal process, and that it could only become illegitimate and illegal by being directed towards the attainment of objects which were subversive of the rights of others or contrary to good morals or public policy—and in such cases the existing law of the land afforded the proper remedy. Thus, if a syndicate were formed for the purpose of forcing a competitor out of business, or for the purpose of cornering the market, or in order to extort exorbitant prices from the consumer, that constituted an offence against public policy and against the provisions of the law governing unfair competition. But if its main objects were to secure greater efficiency by eliminating waste, diminishing the cost of production, regularising supply and demand, preventing needless fluctuations by apportioning and limiting output and fixing prices in order to prevent working at a loss and unemployment, it was deemed to be pursuing objects which in themselves were in harmony with law and with public policy.

It is due in the main to the closer identification of the State in its character as a "captain of industry" with the individual industrialist that the latter, whether alone or combined with others in the form of a cartel, has been influenced to look upon each individual industry as a part of the industrial activities of the whole Empire which, collectively considered, constitute one of the main foundations of that "Deutschtum," or German hegemony, on which the continued growth and progress of the whole Empire, and therefore of every individual German, were believed to depend.

It was often said that in America, *e.g.*, there were only two factors present to the minds of the trust magnates, namely, themselves and their competitors, and that it was the chief purpose of the trust to eliminate the competitor either by killing him without consideration or by swallowing him for a nominal consideration. But in Germany it was said that there were three factors, the third one being the State itself whose welfare had to be considered, and that if any syndicate exhibited a pronounced tendency to forget the claims of the State, the State itself would jog the memory of that syndicate in some one or more of the many and subtle ways in which the Government can effectively impress its will upon the subject. This process is rendered all the easier on account of the inborn attributes of respect for authority and for the principles and practice of discipline, obedience, and organised effort infused into all Germans as a result of universal military service.

Some phases of German syndication of industry hardly seem appropriate to our ideals and system of government, but there are other phases which, I am persuaded, would well repay further examination. Under that most absolute of all monarchs, necessity, Government ownership and control have made enormous strides during the war. We are living in an epoch of temporary State Socialism, and have embarked on huge enterprises on the basis of the nationalisation of industries; but, in so doing, industrial kings and merchant princes have been impressed into the Government services, and have thus at least become partners in the management. There will surely be a reaction after the war, and the old question of nationalisation or Government *versus* private industry will be revived. Also in the not improbable event of a change in the country's fiscal and trade policy, there will arise, according to some people, the danger of the consumer being exploited by huge trusts and combines to grow up under the fostering influences of a tariff and customs duties which will restrict both foreign and domestic competition. But between these two extremes of private industry and complete nationalisation there are, I submit, great possibilities in the direction of *State and private partnership*, especially as regards all undertakings of a public service character. It is altogether thinkable that such a system—if applied, *e.g.*, to the railways and canals of this country so as to afford the necessary degree of Government control and direction exercised from the *inside* through Government representatives on the boards of directors, combined with the advantages of private initiative and business administration—would yield better and more co-ordinated results as well as greater economy and efficiency than have hitherto been achieved, either through complete private ownership, as in the case of the railways and canals, or through complete nationalisation, as in the case of the telephone service.

The basic problem in Germany is the same as in this country or in any other industrial nation. Nationalisation enables an industry or undertaking to be conducted in such a manner

as to promote the national welfare. It can be co-ordinated and linked up with other undertakings; the kind of injurious competition that means working at cross purposes can be eliminated, and unity and harmony of control in the national interests can be secured. But, on the other hand, the absence of private initiative and of the motives of personal profit, which are the ordinary incidents of ownership and management, have a strong and invariable tendency to turn the business into a Civil Service department, to force business principles into the background and to bring Civil Service rules into the foreground. The undertaking ceases to be a business and becomes Civil Service.

Private initiative, on the other hand, focuses its attention too much on the earning of a dividend. If a canal competes with a railway, kill the canal because that will increase dividends. The interests of the railway company are proximate and urgent; the interests of the State are too remote to be allowed for sentimental reasons to interfere with the prime interests of the railway. The result may be altogether advantageous for the railway but equally detrimental to the public interest in transport as a means of furthering the nation's commerce and industry as a whole.

How different would be the position if the Government itself were a shareholder both in the railway and in the canal and duly represented on the respective boards of directors. Under such a system all the undoubted benefits and business efficiency of private ownership and initiative for the legitimate purposes of gain could be preserved, and at the same time as effectively brought into line with the national interests, as if the undertaking were nationalised.

This idea of partnership of the State with the individual has made considerable progress in Germany. Several years ago the German Finance Minister von Miquel attempted to secure the controlling interest in the "Hibernia" coal mines. According to the press accounts, as I remember them, he did succeed in purchasing something over 40 per cent. of the shares, and so far as my information goes the German State to this day has continued to conduct this particular mining undertaking in partnership with the private shareholders of that concern.

Again, the Standard Oil Company acquired not long ago a valuable concession in China, and entered into partnership with the Chinese Government for its exploitation, China receiving for the concession a one-third interest, the Standard Oil Company furnishing the capital and equipment and undertaking the management in consideration of the remaining two-thirds interest.

There are sound reasons, both of a legal and business nature, to justify the participation of the State in large private enterprises on the basis of State and private partnership. As is well known, the introduction of corporate forms of industry and commerce has resulted in substituting the "limited company" for the individual employer. The old-fashioned and friendly relationship between master and servant has developed into the hostile relationship between capital and labour, very largely because a limited company is not a human being but an "artificial person," which, in the words of a famous English judge, "possesses neither soul to damn nor body to kick." Shareholders have taken the place of the master, and *hands* considered as units of labour have taken the place of the apprentice. To make matters worse, a process of insulation has taken place, destroying the immediate human contact between shareholder and labourer; and boards of directors, instead of restoring human sympathetic contact, have all too frequently proved to be non-conductors, and therefore barriers to mutual goodwill.

Something must be done to restore human contact between capital and labour. For the time being the war has furnished us all with that common mutual and uniting impulse, with the result that capital and labour are in the main working in harmony and achieving most remarkable results. My suggestion is that the principle of State and private partnership will tend to restore the connection between capital and labour after the prevailing patriotic impulse has spent itself, and that the State is entitled to an interest in large corporate undertakings, and to a seat on the board of directors, as a consideration for the value given by the State in the shape of the charter or corporate rights and franchises granted to such undertakings and upon which their success in large measure depends.

The State that grants a charter to an undertaking, or permits and enables it to become incorporated under a general law, has a right to demand and receive such a share, at least in the control, as will prevent the danger of those rights and franchises from being used in a manner inimical or detrimental to the public welfare and inequitable to the army of British workers.

V.—Banking and Post-cheque System.

One of the most interesting of the more recent examples of the spirit of progress in German methods is that afforded by the institution of the so-called "post-cheque system." A number of causes have combined to call this system into being. One of the main causes is undoubtedly to be found in the condition of the German banking system. Much has been written about German banks and banking; some are never weary of praising the great efficiency of the German system; others again are not slow in detecting numerous flaws and deficienc es. Both are, in a sense, right. The German banking system is undoubtedly efficient in some directions, and equally deficient in others. Perhaps I may best explain what I mean by saying that it is almost the opposite of the American system. German and American writers and representatives of business have frequently indulged in mutual criticism of their respective banking systems, some of which criticism has been of a decidedly drastic character.

The Germans maintain that the Americans do not understand the theory and philosophy of banking, and that they do not even have a national bank. They say that the only two attempts on record made by the United States to establish a real national bank failed partly because of ignorance of banking science and partly because of the political corruption inherent in American politics.

The Americans, on the other hand, were not slow to point out that, as far as the German banks—considered as institutions of use and convenience to the business world—are concerned, they must be considered as in every way primitive and deficient. The book-keeping is involved and cumbrous; the amount of time which customers are forced to consume in connection with such simple operations as making a deposit is a waste of time and a nuisance; bank clerks and other employees are slow and inexact, have no conception of the value of time, are slovenly, lacking in promptness, and very frequently lacking in business courtesy. The arrangement and office equipment are antiquated, and they are years behind the American practice in the use of calculating machines and other mechanical aids to banking operations. Finally, and most serious of all, the German banks were a hundred years behind the English-speaking world in the use of the cheque as a mode of payment.

On this point in particular the American was able to get back at the German with a good strong counter-stroke touching the theory and philosophy of the cheque, which still seem to be in their infancy in the Fatherland. Whether this backward state of things as regards the use of the cheque was due primarily to the bank or to the defective conditions of the law, is a point of some interest. It is true that the prevailing legal provisions governing cheques are totally inadequate to permit the use of such a cheque as would give the public the same or equivalent guarantees of safety as are afforded under the British or American system. All cheques must be made payable to bearer; cheques payable to order do not exist and are contrary to law. There is, therefore, no need of endorsement, and such cheques, even if endorsed payable to order, are nevertheless treated as payable to bearer. The endorsement is practically without value. For this reason, the giving of a cheque in payment of a debt does not in itself constitute evidence of payment of the debt, and there is no endorsement by the payee to operate as a receipt.

It is, and must remain, one of the interesting paradoxes of German progress that such an abnormally primitive state of things could continue to exist in a community so highly developed in the direction of commercial and industrial efficiency. Eminent Germans themselves have not been slow to agitate for a reform, and during the few years preceding his death, Geheimrath Koch, of the Imperial Bank, made it the main object of his life to press the Government for a reform of the law of cheque, in order that its use might be popularised with safety both for the convenience of the business world and in order to accustom the rank and file of the German people to deal with banks and to entrust their money to the banks, rather than to hoard it up in the family strong box or feather bed.

Slowly but surely the reform movement has set in. The Government, the Chambers of Commerce, professors of economics, the banks, merchants and exporters, and, indeed, the general business public, were gradually becoming alive to the deficiencies of the existing system, and to the necessity for placing the German cheque upon the same basis of usefulness and security as the English or American cheque.

The President of the Society of Comparative Jurisprudence was also interested in the question, and, since he was himself the author of a project for the establishment of a uniform world law of bills, notes and cheques, he devoted his special attention to the necessity of directing the German reform of the cheque in such

directions as would bring it as far as possible into harmony with those principles and legal rules governing the cheque and its use which had, through experience in other countries, been proved to be of sterling value.

The *Post-cheque System* was, in the main, the outgrowth of the agitation in favour of the greater use of the cheque as a medium of payment, but it was also due in part to the evolution of the postal C.O.D. system and the "Geldbriefträger" (lit. "money letter carrier"). Under that system, which could either be employed in connection with the parcels post or independently, it was possible for anyone in any part of the Empire to constitute the General Post Office his *collecting agent* for the presentation of bills and receipts and the collection of the amounts due in any other part of the Empire. What occurred in former years was this: The money letter carrier, on presenting the C.O.D. order usually received payment in bills and specie, and placed the same in his leathern wallet for delivery to the branch post-office to which he was attached. In due course the post-office in which the order originated sent its money letter carrier with an equivalent amount in bills and specie for payment to the creditor.

The same thing occurred when it was desired to remit money by post-office order to a payee in some other part of the country. It is thus seen that the business of remitting moneys as conducted by the German post consisted of the carrying out of (1) orders to *remit*, and (2) orders to *collect*.

In the course of the rapid development of commerce and industry it was becoming more and more apparent that the business community regarded this receiving and paying out of bills and specie as wasteful, inefficient, and irksome—wasteful because it was necessary to keep money on hand instead of drawing daily interest on deposit account in the banks; inefficient and irksome because it was a roundabout method of doing what could be more expeditiously accomplished through the banks. On numerous occasions I have myself received remittances from various outlying parts of the Empire, which were handed to me in bills and specie too late for deposit in a bank on the day of receipt; I have also frequently received larger amounts, several thousands of Marks, and therefore beyond the postal order limit, in the shape of registered letters containing bills, coin and even postage stamps for the fractional amounts.

The waste of time and labour involved in having a money letter carrier paying out sums in this manner, which the receiver immediately sent by another messenger for deposit in his own bank, was so obvious that the postal authorities themselves began to consider ways and means of shortcutting these processes. If the banks of the Empire could remit and collect moneys for their patrons by the use of cheques or orders, and could avoid the actual handling of the amounts involved by the simple expedient of passing such cheques and orders through the clearing department of the Imperial Bank for debit or credit of their patrons accounts, why could not the Post Office do the same? The business public was already accustomed to this modern process, and the banks were deriving profit from the increasing volume of deposit accounts; why should not the rank and file of German subjects also be brought into line both for their own convenience as well as for the resultant benefit of the Postal Treasury?

A scheme was therefore carefully prepared which soon became law, and which provided that any person on depositing £5 could open a post-cheque account, and receive a book of cheque forms with his name or firm printed thereon, and with the serial number of his account. In order to make any number of remittances it was only necessary to pay the covering amount, if not already here, into his post-cheque account and to fill in the names of the payees, whereupon the process of remittance and distribution would automatically be carried out by the post. If the payee had no post-cheque account, the amount would be paid out through the medium of the money letter carrier as formerly; but if he had an account the amount would be credited thereto. The money letter carriers were instructed to explain to the payees that they could save the delivery fee by opening a post-cheque account; these letter carriers thus became an army of propagandists to educate the people to the new idea.

Statements of account were sent regularly by the post to the respective account holders, with a form on which they could direct that such portion of the moneys to their credit, which they might not require as a working margin, should be paid into their respective banks to the credit of their accounts, and I believe—although I am not certain on this point—that this process was accomplished through the medium of the clearing department of the Imperial Bank.

The number of such post-cheque accounts increased very rapidly. The institution did indeed fill a "long felt want." There must at this

time be several millions of such account holders, and, since every million accounts means at least £5,000,000 of deposits without interest—in practice it would be much more—the benefit to the State is very considerable, because on the one hand it has the constant use of that money without interest, while on the other a very material reduction in the labour and number of the money letter carriers, who were more highly paid than the ordinary postmen, was made possible.

Under this system the German Post Office has developed into an enormous Imperial Petty Bank, with a larger number of highly organised branches and skilled personnel than is possessed by all the other banks put together. And this has been accomplished without creating hostility and opposition on their part, because it has relieved them of the comparatively unremunerative business of dealing with small amounts, and has freed them to concentrate their attention on the larger banking business of the German commercial and industrial community.

VI.—Science and Language.

One phase of German development which was very noticeable was the prevalent belief that they had in fact attained to what I may call the "hegemony of science"—that they had become the great source of the world's most advanced scientific thought, and, as a corollary thereto, that the German language had become the standard medium of scientific expression. Henceforth the source and idiom of all true science would bear the Teutonic hall-mark. The claims frequently put forth on behalf of the English language as being a universal world tongue were dismissed as devoid of substantial foundation, and due at most to fortuitous causes of a superficial nature. How, it was sometimes asked, could any language aspire to become a world language when the fact of its widely extended use was due merely to geographical considerations and British ignorance of foreign tongues? According to the German view, the English tongue had become merely a sort of a *world jargon* mainly on account of Britain's geographical extension, commerce, shipping, and the like, taken in conjunction with the Briton's proverbial neglect or disdain of foreign tongues. Its extensive use was not due to any special virtue inherent in the language itself, for it was inexact and unscientific; it had far too many words signifying the same thing, and far too few words expressing scientific differentiation.

The growth of language, it was said, was conditioned upon the growth of thought, and, since scientific thought in Germany had outstripped scientific thought in the English-speaking world and elsewhere, the German language had become a world language of a higher type, based not upon geographical but intellectual dominion. All those who would drink deeply at the source of science must, perforce, do so through the German idiom as the "key language to the world's science." If any one were in doubt about the matter he had only to glance at the enormous output of German scientific books and periodicals in comparison with the output of all other countries together to convince himself of the reality of this fact. I am not qualified to speak on this matter as regards other branches of science, but there are a few facts touching the relation of the German language to legal science to which I may profitably refer.

As preliminary thereto, just a few words on the development of German law. Prior to the founding of the present Empire there existed in the German States a condition of legal confusion. The process of unification and codification had set in with the establishment of the Empire, and achieved its greatest success in the preparation and adoption of the new Civil Code, which went into force throughout the whole Empire on the first of January, 1900. It has been pronounced by those who ought to know to be a worthy successor of the great Napoleonic Codes of a century ago. It has certainly justified its existence, and has served both to popularise legal principles and to increase the practice of order and exactness in the legal relations of the people.

But the scientific appetite of the German jurists for systematising and codifying law was still not satisfied, and craved fresh food from foreign fields. What more inviting field could there be than that afforded by the world-wide commerce and shipping of the Fatherland? Why not collect, annotate, and publish the Commercial Laws of the World? And what other nation was so well fitted as Germany to undertake that work of science? England, now in decline, had not even in the zenith of her commercial and industrial greatness accomplished such a task, and at the present time she was—

"Zu geistig faul um es zu unternehmen; zu oberflächlich um es wissenschaftlich durchzuführen."

[Too mentally indolent to undertake it;

too superficial to accomplish it scientifically.] Therefore, as in the art of war, so also in the arts of peace—"Germans to the front."

Therefore, six or seven years ago, this excellent idea was taken up in earnest. With the patronage and help of various official bodies—professors, judges, lawyers, and others—it was proposed to compile and issue these laws in a number of volumes embodying the polyglot principle. The commercial laws of each country were to be reproduced in the original text and language, and also in the German language on the opposite page. By this means the German language became the common or *key language* in which could be found the commercial laws of all countries. By adopting the method of first compiling and editing the commercial laws of each country in the original language and text of that country, the German publishing house was able to avail itself of the services of the leading professors and lawyers of each country, and when they had completed their work it only remained to prepare the necessary translation into the German language in order to make that language the key language of all trading communities as far as their laws were concerned.

This may truly be said to be a monumental work, comprising some thirty large volumes. The French manufacturer or merchant dealing with Russia can ascertain the laws of Russia by reference to the German version as the key. The Russian desiring to do business with the outside world can find the commercial laws of any country with which he desires to deal both in the original text and in the German idiom.

The value of such a work was evident to all. It was widely sold in Germany, and also in fairly large numbers in various other countries, and, of course, the libraries, chambers of commerce, commercial and industrial associations, and large numbers of private business concerns manufacturing for and exporting to foreign markets were glad to purchase it as a work of reference. In the preparatory task of peacefully penetrating other nations this work constituted a valuable weapon.

Another German compilation which falls under this category is the Patent Laws of the World, compiled and edited by Professor Joseph Kohler, of Berlin. As is well known, the Germans, wherever possible, apply the principle of *quid pro quo*, or reciprocity and retaliation, in their codes and statutes, and in their treaties and arrangements with foreign countries. According to their conception of the principles of Patent Law, the grant of a patent is the grant of a valuable State monopoly. In return for the conferring of such an advantage upon the inventor, he is required to work his patent within the Empire, in order that some part of the benefits and advantages to accrue from the exploiting of the invention may accrue to the German State, in the shape of employment afforded to its subjects and opportunities of investment given to German capital, etc. In default of its working the State may withdraw the monopoly.

It can be seen at a glance that the German inventor, and the capitalist behind him, had the liveliest possible interest in securing due patent protection at home and abroad, and on the most favourable terms. Hence the value of a convenient and fairly exhaustive compilation of the patent laws of other countries in order to enable the largest possible measure of State protection to be secured as a valuable and essential condition for the successful exploitation of his invention in the markets of the world.

Finally there remained the task of rendering the civil laws and codes of the world into German. This project was taken up some years ago by the Berlin Society for Comparative Jurisprudence. Its general intention was to produce a series of works modelled after the pattern of the German Civil Code of 1900. Owing to the progress of codification it was not difficult to secure and translate the civil laws of such countries as France, Italy, the South American Republics, etc., in which the Napoleonic codes or modifications thereof had long been in use.

But in the case of the English-speaking nations the matter was different. It was felt that the English Civil Law (which also included the principles of commercial law) constituted, so to speak, a "key" to the legal systems of all the English-speaking communities of the old and the new world.

But as long ago as 1866 it had been computed that the English judicial decisions occupied more than thirteen hundred volumes and a hundred thousand cases, and the last half century had materially increased that figure. The work of reducing this vast mass of decisions, the statutory enactments and the body of equity law to a systematised and logical series of rules and principles like that of the new German Civil Code appeared to be too great an undertaking for any of the available German professors. Nevertheless, it was imperative that the work should be done, and if the British would persist

in neglecting to codify their law somebody else must do it, because the Germans required it for their own scientific and practical purposes.

An opportunity presented itself, however, to the President of the Berlin Society to interest an English professor in the work, and Professor Jenks was induced to undertake the task and to secure the co-operation of his friends in carrying it through. The work has just been completed, and constitutes an admirable exposition of the principles of English Civil and Commercial Law, formulated in the shape of a Code on the lines of the German Civil Code, and containing some 2,000 odd sections. It is a work possessing both scientific and practical value. It is, so far as I know, the only work from which the foreigner accustomed to codes can get an intelligible idea of English law. If it had been completed at the time that the Japanese were preparing to reform their laws there is every reason to believe that they would have taken it as a model, for it is known that they greatly admired British Courts and administration of justice, but found the law itself too intangible to grasp and take home with them as a model. They therefore took the new German Code instead as their model.

The point I wish to emphasise is that the German regarded this as another example of British lack of initiative and progress. In place of the patchwork of existing statutes and decisions, which no foreigner and but few Britons can intelligently understand, the Germans had stepped in and caused an excellent draft of English law in code form to be prepared, which they could henceforth use to their own great advantage in their dealings with this country for the purpose of peaceful penetration. The German edition of the work is replete with annotations, explanations, historical data, and the various glosses so characteristic of German scientific works in which every nook and corner of the subject is explored.

I have no hesitation in saying that any intelligent German, by a careful study of the work, can make himself more familiar with English law in the same space of time than would be possible for the average Briton to secure by consulting the ordinary legal literature of this country.

VII.—Political.

There are some features of the so-called German constitution which may be referred to with advantage. The Germans, apart from the Social Democrats, imagine that they have a constitutionally responsible form of Government. It would be a waste of words to attempt to demonstrate that this is not so. It is true that they have something which bears an outward semblance to a constitutional form of government, but when analysed it will be found to be merely a form of absolutism masquerading in constitutional garments.

In the United Kingdom and the self-governing British Colonies, and in the other democracies of the world, sovereignty—in the words of Tennyson—is "broad based upon the people's will." The people collectively constitute the broad foundation, then come the people's representatives in Parliament, higher still the members of the Cabinet, who are likewise members of Parliament by virtue of popular election, then the Prime Minister, and finally the Sovereign—a triangle based upon the people, and with the Sovereign at the apex. This picture, with but slight variations, applies alike to this limited monarchy, and all its self-governing dominions, and to the great Republics like the United States and France, with the substitution of an elective instead of an hereditary head. In Germany, there is indeed a Parliament containing the people's representatives, and hence "broad based upon the people's will"—but there the constitutional edifice stops. High above people and Parliament is a Kaiser, by the grace of God, with Ministers chosen by the grace of the Kaiser.

The Kaiser and his Ministers thus constitute a kind of Cabinet of super-Germans, who from their lofty position graciously descend from the German political heaven until they come into touch with the people's representatives on those occasions on which it is necessary to secure the latter's sanction to Governmental measures.

This super-Cabinet is above the Reichstag, but not of it, and the fact that Chancellor and Ministers from time to time take their places upon the tribune and expound their measures and policies, so far as, in their opinion, the people's representatives are entitled to an explanation, does not alter the basic facts of the case. There is no doubt whatever that the Kaiser and his Ministers regard themselves as being primarily charged with the duty and privilege of formulating domestic and foreign policy, and that in so doing they are exercising creative and originating functions of government, and merely go to the people's representatives to secure their approval and obtain the means. There is, therefore, no necessary connection

between the Cabinet and the majority of the popular chamber.

Since, therefore, there is no one party or group of parties in the Reichstag constitutionally entitled or otherwise empowered to form a Cabinet, and dependent for its existence upon its ability to command a majority of the popular chamber, it follows that there is not, and cannot be, a two-party system with a majority charged with and responsible for the business of governing, and a minority exercising the functions of criticism. Wherever in any State the majority is charged with the business of Cabinet building and governing, there is always a dominant tendency at work forcing the popular representatives according to their various political ideals and objects, into alliance with the majority or minority group. Although so-called third parties may appear, and even maintain themselves for a time, they become gradually absorbed into the one or the other group in the course of those processes of reformation constantly going on.

The opposite is true of the German Reichstag. The absence of that compelling necessity to form Cabinets and undertake the constructive work of governing liberates all parties to go their devious ways, and gives unrestrained play to the tendency of segregation which has been so observable in the history of the German peoples. That explains why there are so many different parties or fractions—anywhere from ten to sixteen—in the popular chamber, each with its party organisation and leader. Under these circumstances, nothing could be more grotesque than the exaggerated importance attributed to this or that party by most British and American journalists.

How does the super-Cabinet manipulate these various parties? It does so through the institution of the "Block," as it has come to be known in recent years, especially under the *régime* of the ex-Chancellor von Bülow, although the main features of the system were long practised by Bismarck. Far too little attention has been paid by British writers and students to the working of this system, and the majority of foreign journalists in Germany have not, I think, sufficiently and clearly interpreted to their readers the inner meaning and significance of "block policy."

Neutralisation and *compromise*. Parties were poisonous to Bismarck; he therefore treated them as poisons, figuratively speaking, and contrived to pit them against each other so that one poison would become the antidote of the other and neutralise the action or influence of both. Again, if, *e.g.*, the Conservatives desired a certain measure which was opposed by the Social Democrats, the Chancellor could say to the Conservatives, "Modify your opposition to the Social Democrats or your measure will be defeated"; and likewise to the Social Democrats, "Withdraw some of your opposition to the Conservatives or you will not get your measure through," and thus, by forcing opposing parties to compromise their more extreme demands, the hands of the Government were freed to deal with those phases of the respective bills which the Government most desired, and upon which contending parties could be forced to a compromise on pain of receiving nothing at all. Not only individual parties or fractions, but groups of parties or "blocks," are thus pitted against each other, neutralised, and forced into compromise, in order to enable the Government to push through those legislative measures which it regards as necessary and beneficial.

With the exception of the Social Democrats, the German parties have in the main been content with this form of what they call "strong Cabinet Government modified by Parliamentary action."

Many thinking Germans with whom I have conversed have openly admitted that this system is, in fact, not democratic but eminently suited to the German temperament and State. They maintained that, under the British system, majority and minority were in effect two "blocks," so intent upon butting their heads together and thus neutralising themselves that they frequently accomplished little or nothing, because there was not sufficient independence and reserve power left in the party Cabinet to push through those measures which, whether in the interests of this or that party, were certainly in the nation's interests considered as a whole. Many valuable measures had thus been nipped in the bud, while many other desirable measures had not been formulated and introduced at all. In the car of State, the majority was the motor and the minority was the brake, and they were ofttimes so evenly balanced that the car moved neither forwards nor backwards, but stood still in its tracks. Therefore, there must exist above parties some strong propelling and governing force keeping the interests of the nation, as a whole, constantly in view as the true objective and striving to obtain it, not indeed regardless of popular opinion, but with its aid if its many tongues

could be brought to agree, without its aid where they lost themselves in endless contentions.

This is, in effect, precisely what the German Chancellor in his latest speech (*vide Westminster Gazette*, February 28th) means when, in referring to the immense intellectual, economic and social tasks to be faced after the war, he says, "We can only solve them if our entire strength . . . continues to work in peace time, if paths are created for this strength in which it can freely and joyfully continue to work. This cannot be regulated from the party standpoint, but demands internal strength in the State"—which, in plain English, means that it must continue to be the high prerogative of the Kaiser and Cabinet to lay out the racecourse, and the duty of the people, without question or parley, to do the running.

I have referred to this phase of the German political system because I think it has a vital bearing upon the extraordinary scientific, industrial, and commercial progress of the Empire, and serves to explain why, notwithstanding the multiplicity of parties and the greater multiplicity of conflicting opinions, it has been found possible to put measure after measure upon the statute book, to expand the army, build up the navy, to co-ordinate and develop commerce and industry, and indeed to impart to the whole fabric of the nation's activities a sense of direction and purpose which, so far as material progress is concerned, has challenged the admiration of the world.

Its utter moral failure, however, is being writ large upon the battlefields of Europe.

DISCUSSION.

The Chairman (Mr. Edward Dent), in opening the discussion, said that a great deal had been heard about peaceful penetration by Germany, but he thought a great deal of that peaceful penetration was meant to develop into warlike domination. It had been very interesting to hear what the author said about the support given by the German Government to the various German business houses abroad, and he believed that in many cases the business house was simply a spying agency for the Government, as were also many German missionaries, who acted in combination with German agents in the colonies. He thought the Governments of this country and the colonies were now awake to that fact, and that in most colonies the German missionaries had been interned. Germans had often been considered rather unsuccessful in managing their own colonies, but successful in the colonies of other countries. That idea, however, had now given place to the belief that Germans simply went to other people's colonies to find out what they could of the country, and then to communicate the information to their Government at home. At the time when the war broke out in 1914, the British Association were holding their meeting in Australia, and he believed it was afterwards discovered that some of the German professors who attended that meeting went home with very useful military maps of Australia, which showed that the peaceful penetration of Germany was not always disinterested.

Mr. James Swinburne, F.R.S., said that Mr. Vickery's paper was a most important and interesting work, which ought to be read very carefully when it was published in full. With regard to the point that the Germans simply instructed instead of training character, quite recently a man who knew the Japanese very well told him that he had been discussing the matter with a Japanese who had been in Germany for some time and then came to England, and who thought that, although German education was much more complete and satisfactory in many ways, yet English education produced character while the German system merely produced people containing a certain amount of information. Again, a German book on science would be full of information, and would contain everything that had been done or said or written with regard to the subject with which the book dealt, but there would be no sense of proportion about the book. Ten pages might be devoted to an exceedingly important subject, and twenty pages to one that was of no importance at all. Further, in a German treatise not of the highest standard there might be found all the theories on the subject, although those theories were mutually exclusive. Many people thought that the Germans were an inventive people, but that was not so; practically the only inventions that came from Germany being in organic chemistry. Their method of working almost precluded them from inventing anything. In the early eighties, for instance, America was very active in developing electrical plant and machinery; England was equally active, but was hindered by legislation from doing much in the way of manufacturing. When he went over a particular works in Germany, about the year 1890, he found that they had simply taken English and American practices and combined them, selecting the best of each, and in that way they had developed a huge business. With regard to the author's suggestion that some kind of partnership might be made between the Government and private owners, it seemed to him that the powers of the Government should always be kept down as much as possible. In any Government-controlled business the chief places were occupied by politicians and their friends. If any of those present had had much to do with Government offices they would know that the heads of the different departments would never

take any responsibility. Such things as the Post Office and telephone service might be run by the Government, because they were supposed to be too big to be managed by private individuals; but in other countries they were privately owned, and the financial result of the English Government taking over the telephones was well known. He did not think the combination of the Government with private owners would tend to sweeten the relations between capital and labour, and the Government generally did not get on very well with its labour. With regard to the post-cheque system in Germany, he did not know whether it would be worth while to urge the adoption of that system in England. Many English banks seemed to dislike dealing with small cheques; but he thought if the Government were to take up the matter it would prove more expensive to the community than if it was done through the banks. The Birkbeck Bank had been very convenient in that respect, because, as it charged 1½*d.* instead of 1*d.* for its cheques, it liked people to send small cheques. The postal order system was also useful for sending small sums of money.

MR. F. W. MOORE thought the author had traced the evolution of the German as he was to-day. A man was necessarily the outcome of the conditions and environment in which he was placed, and it seemed to him that the control that had been exercised over the German nation for so many years by the governing class led to the result that the individual necessarily lost initiative and independence of thought. The Germans were the most obedient and almost servile people, in so far as their own Government was concerned, that could be found in any European country at the present time, and there was less independence of thought amongst the Germans in general than amongst any other Continental nation. They liked to be controlled, and could be made to give particulars as to their income, etc., without any trouble whatever, having been trained by a long process of education and police control. He wished the author had touched a little more emphatically on German police control, which was one of the most complete organisations that had ever been devised in any country. If the Government was going to control the nation for the purpose of exploitation it would introduce co-operation, but in doing that it would cause loss of individuality, loss of humanity, and ultimately produce a lower-grade human being. According to all accounts, Germans were capable of the utmost brutality. It appeared that a German soldier was prepared to commit any crime and pass on the responsibility to his officer; that was the outcome of their system of drill and discipline. With regard to Government support for private enterprise, he thought the British Government had a good deal to learn in matters of business before they took over any privately-owned enterprises. In conclusion, he desired to express his appreciation of Mr. Vickery's paper, which he had listened to with great interest.

MR. OCTAVIUS C. BEALE wished to add his testimony to the great value of the paper. He was deeply interested in the subject, because he had taken a great deal of trouble to study the German psychology and also German methods of business. He had recently read a book bearing on the subject entitled "Les Méthodes Allemandes d'Expansion Economique," by Henri Hauser, which he would recommend those present to procure, as they would find it of great value. He remembered in 1885 hearing a German Australian merchant say to a German manufacturer, "We are the Chinamen of Europe," meaning that they were copyists; and it was perfectly true that all the leading inventions were of British origin. Germans had learnt all they knew about railways, electricity, and metallurgy from Great Britain, and then had developed and exploited those discoveries. English people had a power of specialisation which the Germans did not possess, and therefore the Germans did not attain any very great success in commerce in our Overseas Dominions. In Canada, Australia, and South Africa the German farmer would cultivate many things at the same time, whereas the English farmer would turn his attention to one thing in particular and attain perfection in it, so that he easily surpassed the German. In many ways Germany was superior to Great Britain in organisation. As a Royal Commissioner he had taken part in investigating the subject of quack medicines, in regard to which this country enjoyed a notoriety unapproached by any other, whereas in Germany such medicines were under absolute control. Again, with regard to unfair competition, there was no law in this country to protect the honest trader against the dishonest, such as there was in Germany. With regard to the Government of Germany, the point was often overlooked that, if it had not been for the war, the Social Democratic movement might have capsized the whole of the wonderful institutions in Germany. They had already arrived at a representation of 110 in an Assembly of 370, and might have revolutionised the country.

MR. W. S. HOLDER said that Germany had placed her Consuls all over the civilised world, not only to represent German interests, but also at times to represent English interests. That had been, and still was, a disgrace to England as a nation. From time to time the Commercial Travellers' Association, to which he belonged, had entreated the Government to appoint only Englishmen as English Consuls. In Buenos Aires there was a large British Consulate and also a German one, and the difference between the two was so astounding and so alarming that one was led to think that the former was for pleasure and the latter for business. A certain buyer

of goods once went to the British Consulate, where he was treated very politely and given the addresses of between twenty and thirty manufacturers in Birmingham and Wolverhampton who made the class of goods he wanted. He wrote to those manufacturers and received from them, as usual, price lists of their goods, written in English and quoting the prices in English money. Disgusted at that, he went to the German Consul and was shown into a room containing a sample of every kind of article that the Germans could make or procure. He was asked what particular article he wanted, and was taken immediately to that department, the Assistant-Consul who showed him round telling him in Spanish exactly what the article he required would cost him in Buenos Aires, including carriage, duty, etc. Naturally his order went to Germany. There were many German methods that it would not be well to copy, but some of their business methods might well be adopted by this country.

Mr. A. J. David, K.C., agreed with what previous speakers had said in regard to organisation in Germany and the lessons that England might learn from that country. He wished to emphasise the need for the development of technical education in this country, with regard to which Germany had had a great advantage over England for many years past. People in England would not take the trouble to treat low-grade and refractory ores, although that might often be done with advantage. Ore imported into this country from Spain had been discharged in the neighbourhood of Whitehaven, refused because there was a quantity of refractory ore amongst it, re-shipped, taken to Germany, and then treated there. The Germans made it worth while for men to study science, whereas in this country no encouragement was given to research. He hoped one lesson the war would teach us would be to give up living upon our prestige, to take advantage of the opportunities that were given to us, and not to allow Germany to step in front of us in all the Neutral markets of the world.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

KELP INDUSTRY IN BRITISH COLUMBIA.

For several years the question of utilising the supply of raw material to be found in the kelp beds along the British Columbia coast, for the manufacture of potash and other products, has occupied the attention of Vancouver capitalists, and, according to a report by the United States Consul-General at Vancouver, processes have been perfected in recent years by which it is claimed that potash can be produced from kelp at a cost sufficiently low to compete in the American market with potash salts imported from Germany.

A company was organised in 1915, and a plant established at Sydney, British Columbia, for the production of potash and algin. This company is now utilising from thirty to forty tons of raw kelp daily in the manufacture of fertiliser. The product is a fine, dry, but heavy powder. Plans are being made to enlarge the plant and instal special machinery for the extraction of other materials from kelp.

It is believed by the promoters of the industry in British Columbia that the manufacture of iodine and potash, without the production of by-products, would not prove very profitable in normal times, but the increase in the price, especially of potash, on account of the war, will enable the British Columbia Company to include these and other by-products in the output of the factory at Sydney.

Algin, which will be made one of the specialities of the local plant, is said to possess a viscosity many times greater than that of starch or gum arabic. The chief use of algin is for the sizing of fabrics, the effect being to give the material treated the appearance of waterproof sheeting, but leaving it more elastic than when treated by other customary waterproofing materials.

The value of potash imported into Canada annually is about £200,000. It is estimated that the kelp beds on the coast of British Columbia contain sufficient material to manufacture potash, not only for the local market, but for export also.

An Act relating to the licensing of kelp-reduction works, designed especially to encourage the development of the industry and for the protection of persons or companies desiring to engage in the business, was passed by the 1915 session of the Provincial Legislature. The industry is under the jurisdiction of the Minister of Fisheries. A licence protects the operation of any reduction factory for an area extending fifty miles along the coast.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Essential Trades.—External influences command far more attention than any internal developments, and textile industry has, indeed, ceased to develop, save as it may be allowed by the hand of authority. From being a business in which one was free to do as well as one was able, it has gravitated into one in which the manufacturer is free to do as he is told. Progress along the narrowing path is marked by events like the Government purchase of all unsold stocks of raw jute and the discovery that wool cannot be got to execute private orders. Cotton is still a free market, subject only to some safeguards against speculative dealing, but cotton manufacture is ominously absent from Mr. Neville Chamberlain's first list of trades and

occupations of primary importance. The list may conceivably be extended, but the omission is eloquent. Not many men expected to see the day when the greatest textile industry could be written down as of secondary importance. There may, however, be cause of cheerfulness in the fact that raw cotton is excepted from the list of imports marked out for reduction or prohibition. Comparisons are apt to be odious, but a glance may be permitted at the list of primarily important textile trades. "Woollen and worsted manufacture and finishing" under existing conditions excludes nearly all else than Government and export work. There is an imperative need to husband the available resources of wool, but the measures taken to that end have not yet commended themselves to everybody. Of woven wool goods and hosiery, which come next upon the list, over £100,000,000 worth have been purchased by the War Office, and from this eminence the descent to other articles regarded as of first importance is a steep one. Rope and twine figure next, and provoke surprise at the omission of sandbags and some vitally important linen goods. These missing articles are presumably covered by the omnibus clause which includes all munition trades not directly specified. In that case there is a question why silk shalloons are not deemed to be protected by the same general provision, for they are munitions or nothing. These coarse, canvas-like silk cloths are manufactured from silk noils, a by-product of the dressing of waste silk, and are used as cordite containers. Transmission belting is scheduled and, except in the comparatively rare cases where it is made of hair or strong wool, this belting is a cotton duck, painted or coated with balata. The waterproofing of military fabrics is an expressly protected trade and a fairly important one in these times, although not more so than some which obtain no mention.

Restricted Imports.—Some of the textile articles enumerated in the Royal Proclamation have figured in earlier lists of prohibited imports. Cotton hosiery, for which this market has been wont to rely upon foreign sources, is one example. Germany was the main furnisher before the war, since when American and Japanese sendings have become considerable. The large sale of American cotton and artificial silk stockings provoked open dissatisfaction in the Midland centres of industry, but the embargo placed upon imports was postponed and then withdrawn. The pressure of Japanese interests was the ostensibly effective agent, and renewed objections may be looked for from Japanese manufacturers who have installed special machines to make garments in European sizes. The prohibitions upon raw jute, linen, linen yarn and goods are related obviously to the Government desire to control the total supply, and are to be regarded in another light than the restrictions upon superfluities. Silk manufactures, embroideries, cotton lace, gloves, incandescent gas mantles, and unwaterproofed apparel are not luxurious in equal degree, and it is possible that utility will be one consideration taken into account in the issue of licences. There are silks which justify their employment as being actually the most economical articles to use for the purpose, and the origins of the silk goods imported at the present—French, Swiss, Italian, and Japanese—promise some complicating circumstances.

Trade Petitions.—The system of trade licensing, although accepted as a necessity of the situation, has not made itself popular, and a clamour that has arisen for more licences implies no affection for the system for its own sake. A number of Manchester shipping merchants, aggrieved by the delays caused to export orders by the attention shown to home orders, have advocated a new system of priority. They would have exporters licensed, and issue to them labels which would ensure priority for their goods next after Government contracts. The object is defensible enough, but the idea of penalising the rival home traders has not commended itself to the Manchester Chamber of Commerce or to the general sense of fairness. A whole series of manifestoes proposing schemes for the exclusive benefit of export trading has been published, and can hardly be perused without recalling the sectional trade petitions which were so much more common two or three centuries ago. It may, of course, be that the plaintive representations of Manchester exporters to the several departments of State will serve the historian in the future as evidence of industrial conditions during the Great War.

Bulrush Fibre.—A succession of loose screws may be noted in an American newspaper account of German success in devising a substitute for imported fibre. The enemy would have done well to introduce a material capable of replacing cotton or jute or wool, and it is merely destructive of credibility to claim for one fibre the ability to replace all three. What is a good substitute for one makes a bad one for the others, and an account equally enthusiastic about the coarse jute and the finest cotton effects to be derived from one and the same source is an account to be distrusted. This vegetable phenomenon is "a plant called typha, a sort of cat-tail, growing in the marshes" to an estimated weight of five or six million tons a season. It is presumably one of the Typhaceæ, prosaically known as a small bulrush or reed maize, bearing a fruit covered with long down. According to the report, 10 tons of material go to 1 ton of fibre, and if the sanguine vaticinations of a Berlin merchant have been realised, Germany is by

now well on the way to independence of America, Egypt, and India for cotton. Typha growing apparently involves no trouble, and experiment has shown that the cost of manufacture is slight; but it must be assumed that harvesting will mean a certain amount of labour. Typha is seemingly more plentiful in the German marshes than in ours. Cotton is not signally cheap in England, but spinners continue to look abroad rather than use the *Eriophorum vaginatum* or cotton grass, which blows in profusion every year on the Pennines, and is doubtless just as poor a substitute as typha.

Scarce Materials.—An official request to be sparing in the use of chlorine for bleaching purposes has been reiterated, and a suggestion has been offered that the home public might content itself with the lower degree of whiteness obtained by simply scouring cottons in alkali. Were that suggestion accepted, bleaching powder would be released for use upon goods for export to peoples who place exaggerated store upon the pure whiteness of their goods. The importance of maintaining unimpaired the surface character of standard British makes of export cotton goods was perhaps better realised three years ago than it is to-day; but the importance remains. There have been hints of a ban upon the use of flour for sizing cotton cloths; but there should be little to fear upon that score if those in power retain their sense of proportion, and weigh against the small saving which could theoretically be effected the great and permanent cost to British trading interests. The small expenditure in starch and gluten is made remunerative in several ways, and were the continuity of the business broken for any considerable length of time trade of a character valuable even in war days would be lost beyond recall. It is natural to talk of substitutes for flour in this connection; but manufacturers employ all the alternatives that there are, and utilise each for its exact worth in giving the particular character demanded by the market.

OBITUARY.

ROBERT P. PORTER.—Mr. Robert P. Porter died on February 28th from injuries received in a driving accident.

He was born at Norwich in 1852, and after being educated at King Edward VI. Grammar School in his native town he proceeded to America, where, in 1872, he joined the staff of the *Chicago Inter-Ocean*. Devoting himself to the special study of tariff and economic questions, he was appointed United States Tariff Commissioner in 1882; shortly afterwards he was employed in the Census Office as an expert in wealth, debt, taxation, and transportation, and subsequently he became Director of the Census. Under the presidency of McKinley, he acted as Special Fiscal and Tariff Commissioner to Cuba and Porto Rico in 1898, and in the following year he successfully undertook the task of inducing General Maximo Gomez to disband the Cuban army.

In the meantime he had been kept busy with journalistic work. He was on the editorial staff of the *New York Tribune* and *Philadelphia Press* from 1884 to 1887, and in the latter year he founded the *New York Press*. In 1904 he joined the staff of the *Times* as first editor of the *Engineering Supplement*, and he was also responsible for many of the special supplements which have been brought out during the last six or seven years.

He was the author of numerous books, including "The West in 1880"; "Breadwinners Abroad," a study of economic conditions in Great Britain and other countries; "Life of William McKinley"; "Industrial Cuba"; "Dangers of Municipal Trading"; "The Full Recognition of Japan"; "The Ten Republics," an economic and industrial work on South America; and at the time of his death he was completing a short history of Japan for the Oxford University Press.

Mr. Porter joined the Royal Society of Arts in 1905, and in the same year he read a paper on "London Electric Railways," for which he received the Society's silver medal.

CAPTAIN ALEXANDER PETER BAILLIE.—Information has been received of the death, on February 26th, of Captain Alexander P. Baillie, who had been a member of the Royal Society of Arts since 1879.

He joined the 79th Regiment in 1857, received his captaincy ten years later, and retired from the Army in 1869, after having served for some time in India. He was a keen student in many branches of knowledge; among other things he took a deep interest in the study of languages, including French, German, Italian, Russian, and modern Greek.

GENERAL NOTES.

OUTPUT OF COAL IN GREAT BRITAIN, 1915.—The total value of the minerals raised in 1915 amounted to £170,460,949, an increase of £24,597,917, as compared with 1914. The total output of coal was 253,206,081 tons, and the value £157,830,670, showing a decrease in the output of 12,458,312 tons, and an increase in the value of £25,233,817 on the figures for 1914. The average price of coal was 12*s*. 5·60*d*. per ton in 1915, as compared with 9*s*. 11·79*d*. in 1914. The quantity of coal exported, exclusive of coke and manufactured fuel and of coal shipped for the use of steamers engaged in foreign trade,

was 43,534,560 tons. France received over 17½ million tons, Italy over 5¾ million tons, Denmark over 3 million tons, Sweden over 2½ million tons, Norway over 2½ million tons, the Netherlands over 1¾ million tons, the Argentine over 1½ million tons, Spain over 1½ million tons, and Egypt over 1¼ million tons. The total quantity exported from the country was 59,951,925 tons, as against 80,993,890 tons in 1914.

War Office Contracts.—Some remarkable figures have been published showing the enormous quantities ordered on War Office contracts from August 4th, 1914, to December 31st, 1916 (including contracts by the War Office on behalf of the Allied Governments):—

Boots	34,524,000	pairs.
Cap comforters	13,326,000	
Drawers, cotton	5,689,000	pairs.
,, woollen	20,959,000	,,
,, flannel	1,037,000	,,
,, cotton and woollen, short	1,584,000	,,
Gloves, woollen	8,382,000	,,
Socks, worsted	63,565,000	,,
Vests, woollen	9,401,000	
,, flannel	974,000	
Blankets	21,175,000	
Cloth for jackets	42,330,000	yards.
,, trousers	23,687,000	,,
,, great coats	21,558,000	,,
Barathea	2,360,000	,,
Bedford cord	2,305,000	,,
Whipcord, drab	6,064,000	,,
Flannel for shirts	105,102,000	,,
,, hospital and miscellaneous	7,244,000	,,
Duck, tent, cotton	38,060,000	,,
Drill, khaki, cotton	20,870,000	,,
,, drab, cotton	40,516,000	,,
Cotton, grey	11,041,000	,,
Jean, cotton	46,853,000	,,
Flannelette, cotton	23,344,000	,,

Calcium Cyanamide in Canada.—Calcium cyanamide is manufactured on the Canadian side of Niagara Falls by causing a current of atmospheric nitrogen to pass over powdered calcium carbide made red hot in an electric furnace. The Canadian production of calcium cyanamide is at present about 48,000,000 lb. annually, and is rapidly increasing to meet a growing demand. Nearly the whole quantity is exported. Its chief use is as a nitrogenous fertiliser, but it is also used in the production of sulphuric acid. The total value of Canadian fertilisers exported in 1915 was $2,539,789, but this included not only calcium cyanamide, but also sulphate of ammonia produced in the by-product coke ovens of the great iron and steel plants, and small quantities of other fertilisers.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

March 14.—Dr. J. Augustus Voelcker, "Fertilisers and their Supply in War Time." A. D. Hall, F.R.S., Member of the Development Commission, and late Director of the Rothamsted Experimental Station, will preside.

March 21.—G. W. Jones, "Colour Printing, and some Recent Developments." Carmichael Thomas, Chairman of the *Graphic* and *Daily Graphic*, will preside.

April 18. — Horace M. Thornton, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

April 25.—Sir Francis Fox, M.Inst.C.E., "Flour and Bread." Captain Charles Bathurst, M.P., Parliamentary Secretary, Ministry of Food, will preside.

May 2.—J. C. Shenstone, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future."

May 9.—Professor William Ripper, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

April 19.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

Dates to be announced later:—

D. T. Chadwick, I.C.S., "The Future of Indian Trade with Russia and France."

Surgeon-General Sir C. Pardey Lukis, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

Colonial Section.

Tuesday afternoon at 4.30 p.m.:—

May 1.—Philippe Millet, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

ALDRED LECTURES.

Monday afternoons, at 4.30 p.m. :—

LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." Three Lectures.

Syllabus.

LECTURE II.—MARCH 12.—The designing of modern monuments—Architect and sculptor—Influence of setting—Adoption of historical styles—Choice and treatment of materials—Brass, stone, marble, wood, lead—Lettering—Heraldry—Emblems and symbols—Christian feeling in memorial art—Crosses and Calvaries—The churchyard.

LECTURE III.—MARCH 19.—Equestrian figures—Group memorials—Public school, regimental and civic monuments—The War memorial—Teuton *versus* Latin spirit in design—The Christ of the Andes — Columns and arches — Buildings and bridges—Monumental art and town planning.

HOWARD LECTURES.

Monday afternoons, at 4 p.m. :—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Aldred Lecture.) Mr. L. Weaver, "Memorials and Monuments." (Lecture II.)

Electrical Engineers, Institution of (Local Section), Mining Institute, Newcastle, 6.45 p.m. Messrs. F. Gill and W. W. Cook, "The Principles involved in Computing the Depreciation of Plant."

Brewing, Institute of (London Section), at the Birkbeck Café, High Holborn, W.C., 7.30 p.m. Mr. S. K. Thorpe, "Insurances—Marine, War, and Fire—on Barley, etc."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Discussion on Mr. E. Savill's paper, "The Defence of the Realm (Acquisition of Land) Act, 1916."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. (Vernon-Harcourt Lecture.) Mr. E. Crammond, "Foreign Trade and its relation to the Investment of Capital Abroad."

TUESDAY, MARCH 13...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m.

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7 p.m. Mr. G. A. Juhlin, "Voltage Regulation of Rotary Converters."

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Dr. F. W. Thomas, "The Training of the Sanskrit Poet."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. W. Gregory, "Geological War Problems." (Lecture I.)

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. J. M. Orr, "A Plea for Mural Painting."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. D. Seth-Smith, "The Photography of Wild Animals in Captivity."

Prehistoric Society of East Anglia, at the Anthropological Institute, 50, Great Russell-street, W.C., 2 p.m. 1. Presidential Address by Dr. A. E. Peake. 2. Mr. R. A. Smith, "Plateau Deposits and Implements." 3. Mr. J. R. Moir, "The Position of Prehistoric Research in England."

Anthropological Institute, 50, Great Russell-street, W.C., 5.30 p.m. 1. Address by the President, "Some Prehistoric Questions." 2. Mr. A. L. Lewis, "The Menhirs of Madagascar."

WEDNESDAY, MARCH 14...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Dr. J. A. Voelcker, "Fertilisers and their Supply in War Time."

Automobile Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. L. Hodgson, "Air Screws."

Oriental Studies, School of, London Institution, Finsbury-circus, E.C., 5 p.m. Dr. T. W. Arnold, "The Study of Arabic."

Public Health, Royal Institute of, 37, Russell square, W.C., 4 p.m. Dr. E. L. Collis, "The Protection of the Health of Munition Workers."

THURSDAY, MARCH 15...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Mr. C. E. Jones, "The Preparation of Plants for Exhibition." 2. Dr. R. R. Gates, "A Systematic Study of the North American Melanthaceæ from the Genetic Standpoint."

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Misses C. Agutter and E. M. Smith, "Vocational Guidance in the School."

Chemical Society, Burlington House, W., 8 p.m. Lecture by Dr. H. T. Brown.

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Dendy, "Sponges: a Study in Evolutionary Biology." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. C. H. L. Emanuel, "The Light Side of Photography."

Historical Society, 22, Russell-square, W.C., 5 p.m. Rev. H. Gee, "The Derwentdale Plot (1666-1668)."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

City of London College, White-street, Moorfields, E.C., 5.30 p.m. Mr. W. E. Warner, "Refrigeration in the Fish Trade."

FRIDAY, MARCH 16...Royal Institution, Albemarle-street, W., 5.30 p.m. Sir John Stirling-Maxwell, "Scientific Forestry for the United Kingdom."

University of London, University College, Gower-street, W.C., 4.30 p.m. Dr. T. Borenius, "Tuscan and Umbrian Art of the Renaissance." (Lecture IX.)

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. 1. Sir W. Beardmore, "Heat Treatment of Large Forgings." 2. Mr. H. B. Ashdown, "Heat Treatment of Steel Forgings."

SATURDAY, MARCH 17...Royal Institution, Albemarle-street, W., 3 p.m. Dr. C. W. Saleeby, "Imperial Eugenics—Saving the Future." (Lecture II.)

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Journal of the Royal Society of Arts.

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FRIDAY, MARCH 16, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. 2.

DEATH OF H.R.H. THE DUCHESS OF CONNAUGHT.

The Fellows of the Royal Society of Arts will desire to offer their respectful condolence to H.R.H. the Duke of Connaught, the President of the Society, on the occasion of the lamented death of his beloved and popular Consort.

NOTICES.

NEXT WEEK.

MONDAY, MARCH 19th, at 4.30 p.m. (Aldred Lecture.) LAWRENCE WEAVER, F.S.A., "Memorials and Monuments." (Lecture III.)

WEDNESDAY, MARCH 21st, at 4.30 p.m. (Ordinary Meeting.) G. W. JONES, "Colour Printing, and some Recent Developments." CARMICHAEL THOMAS, Chairman of the *Graphic* and *Daily Graphic*, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1917 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 24th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

1864, Sir Rowland Hill, K.C.B., F.R.S.

1865, His Imperial Majesty, Napoleon III.

1866, Michael Faraday, D.C.L., F.R.S.

1867, Sir W. Fothergill Cooke and Sir Charles Wheatstone, F.R.S.

1868, Sir Joseph Whitworth, LL.D., F.R.S.

1869, Baron Justus von Liebig.

1870, Vicomte Ferdinand de Lesseps, Hon. G.C.S.I.

1871, Sir Henry Cole, K.C.B.

1872, Sir Henry Bessemer, F.R.S.

1873, Michel Eugène Chevreul.

1874, Sir C. W. Siemens, D.C.L., F.R.S.

1875, Michel Chevalier.

1876, Sir George B. Airy, K.C.B., F.R.S.

1877, Jean Baptiste Dumas.

1878, Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

1879, Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

1880, James Prescott Joule, LL.D., D.C.L., F.R.S.

1881, Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

1882, Louis Pasteur.

1883, Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

1884, Captain James Buchanan Eads.

1885, Sir Henry Doulton.

1886, Samuel Cunliffe Lister (afterwards Lord Masham).

1887, HER MAJESTY QUEEN VICTORIA.

1888, Professor Hermann Louis Helmholtz.

1889, John Percy, LL.D., F.R.S.

1890, Sir William Henry Perkin, F.R.S.

1891, Sir Frederick Abel, Bt., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

1892, Thomas Alva Edison.

1893, Sir John Bennet Lawes, Bt., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

1894, Sir Joseph (afterwards Lord) Lister, F.R.S.

1895, Sir Isaac Lowthian Bell, Bt., F.R.S.

1896, Professor David Edward Hughes, F.R.S.

1897, George James Symons, F.R.S.

1898, Professor Robert Wilhelm Bunsen, M.D.

1899, Sir William Crookes, O.M., F.R.S.

1900, Henry Wilde, F.R.S.

1901, HIS MAJESTY KING EDWARD VII.

1902, Professor Alexander Graham Bell.

1903, Sir Charles Augustus Hartley, K.C.M.G.

1904, Walter Crane.

1905, Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.

1906, Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

1907, The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.

1908, Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

1909, Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S.

1910, Madame Curie.

1911, The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.

1912, The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S.

1913, His Majesty King George V.

1914, Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.

1915, Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.

1916, Professor Elias Metchnikoff.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 14th, 1917; Edward Packard, F.C.S., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Brunjes, Thomas Alfred, F.C.S., M.S.C.I., 94 Waller-road, New Cross, S.E. (14)

Casson, Herbert N., 4, Lincoln's Inn Fields, W.C. (2)

Gardiner, Frederick Ambrose, F.L.S., 12, The Ridgeway, Golder's Green, N.W. (4)

Hyett, John E., A.R.C.A., 4, St. Oswald's Studios, Sedlescombe-road, West Brompton, S.W. (10)

Noronha, Edward Joseph, J.P., Messrs. Noronha & Co., Hong-Kong, China.

Vickery, James Harris, LL.B., 4, Lincoln's Inn Fields, W.C. (2)

The following candidates were balloted for and duly elected Fellows of the Society:—

Bartle, George William, M.I.Mar.Eng., A.M.I. Mech.E., 27A, Mile End-road, E. (1)

Das, Manmatha Nath, B.A., A.M.I.Mech.E., 19, Waverley House, Kenton-street, Russell-square, W.C. (1)

Edwards, R. Jestyn, Brynawel, Alltwen, Pontardawe, Glamorgan.

Wolseley, Lady, Wolseley, Stafford; and Brown's Hotel, Albemarle-street, W. (1)

The paper read was—

FERTILISERS AND THEIR SUPPLY IN WAR TIME.

By John Augustus Voelcker, Hon. M.A.(Camb.), Ph.D., F.I.C.

The nation has just begun to wake up to the fact that agriculture is an essential, perhaps the most essential, industry. Hitherto it has been neglected and made to give place to almost every other interest; but now that we are going through a terrible war it is recognised, as has long been the case in Germany, that the question of the supply of food from within a country's own borders is one of vital importance.

The farmer is now called upon to produce more food, and anyone acquainted with agriculture knows that this cannot be done without the use of fertilisers of one kind or another. Where land has been so long under cultivation as is the case with the arable land in the United Kingdom, reliance can no longer be placed on the natural fertility of the soil, and for long it has been recognised that whatever benefit may accrue from crop-growing can only come from the extra crop obtained by judicious manuring.

The call for greater food production comes at a time when the farmer is, perhaps, the least prepared for it. Hampered by uncertainties as to prices, with depleted labour, shortage of machinery, and other factors into which I must not enter, he is faced with the additional difficulty which it is my province now to deal with—the shortage and high prices of all kinds of fertilisers. Nor is the trouble to be laid to the charge of the manufacturer of artificial fertilisers, for he in his turn finds himself surrounded by exceptional difficulties in the scarcity and heavy cost of transport of both raw and manufactured produce, shortage of labour, and, primarily, the fact that he is unable to obtain the supply of sulphuric acid which is so essential to him in his manufacture of superphosphate and other dissolved manures, in order to meet the farmers' requirements. These causes have all combined to raise the cost of fertilisers to figures quite unprecedented, while they have also reduced the supply to such an extent as to make them often almost unprocurable. It is a matter of common knowledge that a farmer wishing to use superphosphate for a corn or root crop may have to wait quite three months before he can expect to have it delivered to him; while the supply of other fertilisers, such as basic slag, is so limited that he may even be unable to get them at all. This, in face of this urgent call to produce more food for the maintenance of the nation at this time of crisis, invests my subject to-day with special importance.

It is not my intention to detain you with a consideration of the importance of fertilisers in our agricultural system, nor to illustrate the uses and methods of action of different fertilisers, nor, again, to draw comparisons between the use of them in this country as against others,

but I intend to go straight to the point at issue —what are the present conditions of supply, what are the needs, and how can these be best provided for?

While there are many chemical constituents which exercise an influence upon plant life and growth, those which are most directly concerned in crop-production of the farm are phosphoric acid, nitrogen, potash, and, to a lesser extent, organic matter or humus, and lime. So far as the manufacture of artificial fertilisers goes, this is, for all practical purposes, concerned with the supply of phosphoric acid, nitrogen, and potash; and with these I shall mainly occupy myself, and deal with them in order.

The most common of all fertilisers is, of course, farmyard manure, comprising in itself the foregoing three constituents as well as organic matter and other bodies. The supply of it is, however, a regularly decreasing one, and the great rise in the price of feeding-stuffs experienced since the war began has made it increasingly expensive to produce. As a consequence, dependence will more and more have to be placed on artificial fertilisers. Some of these, as, *e.g.*, superphosphate, aim at providing one constituent only, phosphoric acid, in one form or another; so with nitrate of soda and sulphate of ammonia, which provide nitrogen; whereas others aim at combining both these ingredients and occasionally potash as well. While it is not possible to divide them strictly into classes, we may yet well consider them from the point of view of what they mainly supply.

A.—PHOSPHORIC ACID.

To take, first, fertilisers that mainly supply phosphoric acid. We have under this head superphosphate, basic slag, and ground phosphates, as calling at the present time for most attention. In fact, one might say that for all practical purposes the present-day question of the supply of phosphatic fertilisers resolves itself into that of providing superphosphate and basic slag. True it is that there are other materials, such as bones in their different forms, guanos, such as Peruvian and meat and fish guanos, which may help towards meeting the phosphatic supply, and there is also the great group of "compound manures," which are all more or less phosphatic in composition, but bones and guanos are restricted in their supply and use, and "compound manures" may be regarded as "variants" of the more widely used superphosphate, of which, indeed, they are often largely composed.

Superphosphate.

Superphosphate may indeed be taken, under existing circumstances, as the type of dissolved phosphatic manures, just as basic slag may be regarded as that of the raw or undissolved. It is long since Liebig first showed the great advantage of treating bones with sulphuric acid, thus rendering the phosphate of lime soluble and enabling it to act more quickly upon the crop; while Lawes, following up the discovery and applying it to ground mineral phosphates, laid the foundation of the great "superphosphate" industry which has flourished to this day. The attempt has often been made to utilise raw phosphatic materials by grinding them finely and spreading them on the land, but until the advent of basic slag this has never met with any marked success, and it has been found much the more profitable way to convert the phosphate into superphosphate. The advantage of this is well seen in growing a turnip crop, the application of the readily soluble and quickly-acting phosphate enabling the young plant to push on in its early stages and thus escape the ravages of the "turnip-fly."

I have spoken of "compound manures" as being practically "variants" of superphosphate with the addition of other materials of a nitrogenous and occasionally potassic nature as well, and, as I do not intend to refer to these again, I may dismiss them by saying that their main purpose is to save the farmer trouble. I will not deny that in many cases they are carefully and intelligently compounded, and sometimes with due regard to the crop for which, and the soil on which, they are to be used. But I cannot pretend that I place, as a rule, much store upon the fact that this manure is called "wheat manure," the other "barley manure" or "oat manure," and that others are described as "turnip manure," "mangold manure," and so forth. In reviewing circulars in which these manures are set out with their respective analyses, I am often at a loss to know wherein the differences between them really lie, and I should not be disposed to share the anxiety of the farmer who found that by some mistake he had applied "oat manure" to his barley crop instead of "barley manure," or had put "mangold manure" on his swedes! In Germany—where, by the way, fertilisers are used to a very much greater extent than in our own country—the farmer has assimilated very much better the teaching of agricultural science as emanating from his provincial experimental station ("Versuchsstation"), and he orders manures to supply so many pounds of phos-

phoric acid, nitrogen, etc., according to the requirements of his crop, and not merely so many tons of this or that "special manure."

Dissolved bones may well be classed with superphosphate, as may also the large class of manures known as "bone manures," these consisting generally of bones more or less dissolved, with admixture of ordinary mineral superphosphate.

The raw phosphatic materials, whether they be phosphatic rock or bones, are ground and then treated with sulphuric acid, the supply of the latter being thus all-important. Of phosphatic rock the principal sources at present are those from Northern Africa, and comprise Gafsa, Constantine, Algerian and Tunisian phosphates, Egyptian phosphate, together with some Curaçao and Ocean Island rock phosphate. The difficulties of obtaining freight militate, of course, greatly against the obtaining of large stocks of these; but, so far as I have been able to ascertain, there would seem to be sufficient raw material in stock to work up into superphosphate if the acid for so doing were available. The larger fertiliser factories make their own acid, though many of them in normal times purchase acid as well. The smaller factories distributed over the country purchase their acid. At the larger works not merely "chamber acid" of about 66 per cent. strength, such as is used for ordinary superphosphate making, is produced, but a stronger acid, of about 80 per cent. strength, is obtained from the Glover towers, and there is plant also for preparing a pure and concentrated (95 per cent.) acid, freed from arsenic, and such as is suitable for the manufacture of high explosives.

Since the commencement of the war, as is well known, all these sulphuric acid-producing works have been put under Government control, and set to produce acid as hard as ever they can. So urgent indeed has been the call for the supply of sulphuric acid for munition purposes that these works have been continuously working at full pressure, and in many cases considerable extension of plant has had to be provided, and special installation of plant for concentrating and purifying the acid. With this, in face of the country's needs, no one can complain, and it was clearly the right thing to do. But the effect upon agriculture has been serious, and has resulted practically in a "superphosphate starvation." It is reckoned that quite 50 per cent. of the acid which normally would be available for the manufacture of artificial fertilisers has been withdrawn from its general use. As a consequence, it has been impossible to work up the stocks of raw phosphatic material, and the farmer has had either to do without superphosphate, or to take his chance of when it may be delivered to him. Farmers, it must be said, are not given, as a rule, to order their fertilisers long before they require them for use, and they do not care to have them long stored at their farms; so that it is not usual, except with large farmers and the more enlightened ones, to make their contracts long beforehand. The result of this is seen now, for it may be taken that any farmer ordering superphosphate to-day would have to wait quite three months before it could be delivered to him. The factories are still going on making superphosphate as they have opportunity and acid to spare, but in many cases what superphosphate is made goes largely to form the base of the "compound manures," which offer a considerably wider margin of profit to the manufacturer than does the sale of superphosphate itself. In this connection, it is said that some of the smaller works throughout the country possess an advantage, in that they only make a weak acid which is not worth transporting, and so they are allowed to continue using it for fertiliser manufacture.

Simultaneously with this "holding up" of the acid supply comes the call to the farmer to produce more food crops, to grow more corn, to plough up grass land and put it in wheat or oats or potatoes. And now he is practically deprived of the main source which is to help him to achieve the object. The time of winter sowing of wheat has gone by, an unusually hard and prolonged winter has left the land frost-bound, and will necessarily greatly delay the period of spring-corn sowing. It is under such circumstances that the farmer will more than ever need the quickly-acting fertiliser recognised to be so necessary for his spring corn-crops, as well as for his root-crops. To ask him, then, to produce more corn, and without giving him the necessary superphosphate, etc., is, leaving aside the other difficulties that he has to contend with, like asking him to "make bricks without straw."

I shall probably be asked what remedy I have to suggest for this state of things, whether I can recommend any substitute that has been proposed for superphosphate or have any other to put forward. I cannot say that there is any adequate substitute, nor that I see any prospect of a better state of things so long as we have one Department of Government working, not along with, but sometimes directly contrary to the interests of another. I cannot but acknow-

ledge, as must every true Britisher, the paramount call for more munitions and for more men, and that it must be the first concern to "win the war." Agricultural requirements must necessarily come secondary to the provision of munitions and men, and yet one cannot but feel that there ought to be a better interworking among Government Departments, for while the War Department is taking men away from the land, and the farmer cannot get his fertilisers, it is hopeless to expect him to produce more food for the nation's supply. One would think that it would be possible, while maintaining the output of munitions at the necessary rate, to spare enough sulphuric acid for the regular manufacture of fertilisers, though the supply of these may have to be limited. So far as the farmer is concerned, it is not a matter of price, it is the sheer inability to provide him with what he requires. Nor can the blame be put upon the manufacturer, for there is no reason to think that he is profiting by the larger outturn of acid, but that he would prefer, if he could, to meet the agriculturists' requirements. This is especially felt in places where manure factories have been established in country districts by the farmers and are largely maintained for their benefit. I am glad to learn within the last few days that arrangements are now in contemplation by which not only it may be possible to set free a larger supply of sulphuric acid for fertiliser manufacture, but also to provide for the shipment of more raw phosphatic material, the stocks of which, though not actually run out, are considerably depleted, and will need replenishing in view of the requirements of another season. This is, clearly, what should be done.

Substitutes for Superphosphate.

As a substitute for superphosphate there has been put forward what is known as "war-time superphosphate." Under this name is sometimes sold a mixture of superphosphate and ground mineral phosphate, half and half, with rather less than half the amount of "soluble phosphate" that superphosphate has. As a way of eking out the limited supply of superphosphate this is quite a good "makeshift," though it may be expected to "go back," on keeping, to the extent of, say, 3 to 4 per cent. in "soluble phosphate."

Another plan of making "war-time superphosphate" has been strongly urged by the Board of Agriculture upon makers of artificial manures, and that is to utilise, for dissolving purposes, the free sulphuric acid present in "nitre-cake"—a material produced in the manufacture of sulphuric acid, it being the residue left after treatment of nitrate of soda with sulphuric acid, thereby giving nitric acid for the evolution of the nitrous gases which pass into the chambers. This residue is essentially a sulphate of soda which contains something like 30 per cent. of free sulphuric acid, together with variable quantities of nitric acid compounds. The free acid, it has been suggested, might be utilised to replace or at least to supplement the acid available for dissolving use.

In some cases manufacturers have simply ground up the nitre-cake and have mixed with it ground mineral phosphate, and called this "war-time superphosphate." This, to my mind, is a wrong statement, and the material should not be called "superphosphate." The acid sulphate of soda will not decompose the phosphate rock by merely mixing the two materials together, and it is only when water or acid is added that there is any real reaction.

But where sulphuric acid has been used along with the nitre-cake the case is different, and here a considerable proportion of the phosphate may be rendered soluble. There are, however, great difficulties experienced in dealing with these materials, and it is hard to obtain a product in good condition and free from pastiness. The matter is very rightly engaging attention, and, though some manufacturers have said they cannot "work" it, others have met with some share of success. Could a waste product like nitre-cake be utilised in this way it would undoubtedly, when acid is scarce, be a great boon and supplement the supply of acid. Unfortunately, however, all such attempts require extra labour, and, possibly, additional plant, and this at a time when the manufacturer can least afford either.

I shall revert to this question of the utilisation of nitre-cake when dealing with sulphate of ammonia manufacture.

Ground Phosphates and Basic Slag.

Though these represent two quite different classes of phosphatic materials, it will be convenient to group them together, for, in the assessing of their value on the land, come in two considerations which have not until recent years entered. These are (*a*) fineness of grinding, (*b*) solubility in citric acid solution.

It has been mentioned that treatment of phosphate rock with sulphuric acid was found to render the phosphates far more available, and

though attempts were made in the early days by Aitken and others to utilise ground mineral phosphates as direct applications to the land, these never obtained much success. It is probable, however, that the fineness of grinding now reached in the case of basic slag was not then attainable, for experiments have more recently been put forward in which it is maintained that some class of mineral phosphates, if ground as finely as basic slag generally is, will answer just as well. However this may be, it remains the case that phosphates are but little used without treatment, but that basic slag is. It behoves us, therefore, to examine more in detail the claims put forward in regard to basic slag. This, as is well known, is the slag produced in the Thomas-Gilchrist process of dephosphorising iron, a process particularly adapted to ores containing phosphorus, the removal of which is necessary in order to make a good steel. The Bessemer converter is lined with magnesian lime, and in the process of conversion a slag forms, which is run off, and in this the phosphorus is found, occurring, some say, as a tetra-basic phosphate of lime, others as a silico-phosphate of lime. For a considerable number of years this slag accumulated in great heaps at the works, for, though tried on the land, it never seemed to do any good. It was then that the plan of grinding it very finely was tried, and the results, at least on grass land, were of a most striking nature. From that time on, the accumulated heaps of basic slag were worked and ground down for agricultural use, and it is only right to say that hardly any discovery within the last thirty years in the practical line has proved so useful agriculturally as has that of the utilisation of basic slag. It was in Germany, however, that it received its special impetus, alike by the business energy of its promoters and the advocacy of the well-known agricultural chemist Wagner. Indeed, this advocacy is responsible for some claims of doubtful value put forward for basic slag. The first idea was to "push" it as against the universally-employed superphosphate, and to aid in this there was utilised the discovery made by Wagner that basic slag, if treated in certain proportion with citric acid of certain strength and for a particular time, allowed a large part of its phosphoric acid to pass into solution. This was called "citric soluble" phosphate, and the name has, mainly through the "pushing tactics" of the promoters, now practically become universal and recognised alike by the trade and by legislation. Further than this, the "solubility" in the particular solution recommended by Wagner and under the particular conditions which he set out, has come to be the test for what is called the "available" phosphoric acid in basic slag, no other phosphate than this being recognised as possessing any appreciable manurial value.

I have myself always been opposed to this view, and to the practice it has given rise to. The most that I could see my way to was to admit that, on general grounds, one might say that the phosphate which was soluble in a weak organic acid might be expected to be more readily available for plant use than that not so dissolved. But to allow this as a quantitative measure of value I could never consent. Nor, seeing that citric acid does not exist in the soil, and that roots do not obtain their food from the soil by means of it, and that the soil is not in contact with the basic slag for half an hour only but for many half hours, do I see the wisdom of tying oneself down to a purely arbitrary and conventional method of procedure. It is well known that a different strength of citric acid employed, and different conditions used, would give totally different results, and, more recently, it has been shown that successive treatments of ground phosphate rock with citric acid will remove practically the whole of the phosphate. Why then a particular organic acid of a particular strength, and employed for a particular period, should become the test of value of basic slag I do not see. It would be much more reasonable to take carbonic acid as the solvent, inasmuch as this does occur in the soil, and exercises a great influence in rendering the constituents of the soil available. Still less do I see why other basic slags, which do not conform so readily to this test, should be rejected as worthless or nearly so, and without a practical trial of them.

So hard, however, has the "citric-soluble" doctrine been "run," and primarily from purely commercial and interested motives, that it has become an "article of faith." The practical outcome of this is that though large quantities of slag are produced in this country by the "open-hearth" process, and though these contain quite considerable amounts of phosphoric acid, they are not utilised, simply because they are less soluble in a 2 per cent. citric acid solution than those coming from the Bessemer process. Not only this, but so strongly were the "citric-soluble" views insisted upon, that, previous to the war,

it was the custom to import basic slag from the Continent for use here; and now that this import is stopped we have a great shortage in our basic slag supply, for, though not absolutely unprocurable, it only comes forward in limited amounts and at uncertain intervals. This, to my mind, when basic slag is so much required for pastures and production of meat, is very regrettable, especially in view of the fact that tons and tons of basic slag are lying about unutilised, and mainly because they do not conform to the "citric-soluble" test. I certainly feel strongly that these lower-quality slags ought to have a more thorough trial given to them, and not be dismissed as useless.

The fact is that there is something very peculiar about the action of basic slag, and this no chemist has yet been able fully to explain. The benefits have been variously attributed to the fineness of grinding, to the presence of lime, to the "citric-soluble" phosphate, etc.; but none of these is in itself sufficient to explain its value. Judging bone dust or precipitated phosphate by these standards, they should prove as efficacious, and yet everyone knows that this is not so. Again, no adequate explanation is forthcoming of the recognised fact that it is on grass land, essentially, that basic slag works often such wonders, and more especially on cold heavy soil, whereas on light soil it frequently is entirely without benefit if used by itself. Why should these undisputed results follow its employment on grass land and not be equally apparent on arable crops? I frankly confess I have never yet been able to say on what land basic slag is likely to answer; the only advice I can give is to "try it," and, if it answers, use it freely. But, though many experiments have been tried with it in comparison with other fertilisers, I am not satisfied that any of these have yet pointed to the real cause of success; for all I know, it may yet be found in some or other of the more or less neglected constituents of basic slag. Equally unsatisfactory, to my mind, are the experiments—especially those of Wagner himself—which have sought to establish the value of basic slag as resting in the "citric-soluble" phosphate. There is, then, something very peculiar about basic slag which makes experimenting with it a very difficult matter, and in my own experiments, alike on high-grade and on low-grade slags, and on high citric-solubility and low, I have not as yet succeeded in getting results that convince me. In face of this and the national needs, I repeat, therefore, that the accumulated stocks of lower-grade and lower-solubility basic slag should be worked up and made available for the farmers' use. In a recent paper Professors Gilchrist and Louis, of Newcastle-on-Tyne, estimate that in this country there are 740,000 tons of "open-hearth" slag as against 120,000 tons of Bessemer slag. In Germany, on the other hand, previous to the war, the Bessemer slag produced considerably exceeded the "open-hearth" slag, and so it was to trade interests to push the "citric-soluble" system of valuation.

If my remarks as to citric solubility tell against basic slag, how much more should they against a material which, though sold under the name "basic phosphate," and stated to contain "soluble phosphates," and to be a "substitute for superphosphate," is nothing more than ground mineral phosphate, advantage being taken of the fact that, by using a very little of it with a very large volume of very dilute citric acid solution, the greater part of the phosphates will be rendered soluble. This is to bring the whole test, and any merit that may be attached to it, into disrepute; and it shows, further, the evil of extending the term "soluble phosphate" to other than what is soluble in water, as in the case of superphosphate.

Bones and other Phosphatic Materials.

In superphosphate and basic slag I have dealt with the principal phosphatic manures that the farmer requires—the former for his arable crops, the latter for his pasture. To a far lesser extent come in bones in their different forms—fish and meat guanos, and Peruvian guano. Then there is the whole class of "compound manures," which, though not purely phosphatic, are so in their basis, and may be considered with superphosphate. Bones have of late been coming somewhat freely from the camps in France and elsewhere, and may be obtained either ground into bone-meal, steamed to remove the gelatin and sold as "steamed bone flour," or, again, treated with sulphuric acid to form "dissolved bones" or the different varieties of "bone manure." As with all other fertilising materials, the price of bones has gone up tremendously, and what before the war cost £6 or £6 10*s*. per ton, cannot be had now for less than £9 or £9 10*s*. per ton. Bones, moreover, are valuable, in no small measure, because of their more "lasting" effect; but this, at a time when the country requires the rapid production of food crops, is not of so

much consequence, and the farmer naturally turns to the cheaper and quickly-acting superphosphate. For the same reason basic slag is not so likely to be used for arable crops if other supplies are available, and in any case it is known that it must be applied early. The severe and prolonged winter will make the preparation of the land for spring-sown crops both difficult and late, and so the need of a quickly-acting fertiliser like superphosphate will be all the more felt.

Fish guano and meat guano are used mainly for special crops like fruit, hops, etc., and do not affect the general agricultural supply largely. Fish manure may still, I hear, arrive from local sources, but the import of meat guano (from the River Plate) is practically closed for the present. Of Peruvian guano there are still some stocks left, and this fertiliser can be purchased either as "raw," "equalised," or "dissolved" Peruvian guano. Its price has hardly risen proportionately to that of other fertilisers, and the fact that it combines at once phosphates, ammonia, and potash in active forms makes it still a favourite with many, and now, when potash salts are not generally available, the presence of potash in this natural fertiliser is not to be ignored.

It will be seen from this summary of the position, that superphosphate and basic slag are the two phosphatic fertilisers that the farmer is in need of, and with which he must be supplied if he is to contribute materially to an increased yield of corn and meat.

B.—NITROGEN.

To one who, like myself, has been "brought up" on the "Nitrogen question," and has carried out many inquiries on, and entered into many discussions about, the relative forms of nitrogen in fertilisers and their respective values, it is somewhat amusing to find how the question has, under the stress of the war, resolved itself as a practical measure into the supply of one material only, viz., sulphate of ammonia. And this because sulphate of ammonia is the one home product. For phosphates, the limited stores of coprolites found in this country have long had to give place to richer materials from abroad which allow of more ready and economical manufacture. Sulphate of ammonia, though a home product, has been, I will not say neglected, but only thought of on the basis of how it stood in comparison with nitrate of soda or other nitrogenous sources, and without any regard to whether we might not some day have to depend on our own products. Farmers are no different from other folk in this respect. The matter of cost, and not the Imperial outlook, has been the guiding feature in all our transactions. Now, however, that we are reduced to it, we ought to be thankful that there is such a supply available and in such profusion, but equally so it behoves our Board of Agriculture and the Government generally to see that the supplies we require are kept for the country's use.

Nitrogen, it has been recognised since the days of the noted controversy of Lawes and Gilbert with Liebig—the advocate of the "mineral theory"—is the constituent upon which our corn crops particularly depend for their rapid growth when the advent of summer sets them "going," and nothing has been found so effectual for their rapid "pushing on" at this stage as have nitrate of soda and sulphate of ammonia. Fierce often has been the struggle between these for recognition, advocates of the merits of one against the other have been legion, volumes have been written about them, experiments galore, till we have finally settled down to regard it as—in most cases—more a matter of the price at which we could purchase the unit of nitrogen in each than of anything else. Now, however, has come in the war to settle, for the time at least, the question between the rivals—for nitrate of soda is to all intents no longer available for agricultural purposes. Added to the difficulties of shipment—it all coming from the west coast of South America—is the fact that it is all required in connection with the manufacture of explosives, either directly or for making the all-essential nitric acid. When procurable at all, its price is £21 to £22 per ton, which, compared with sulphate of ammonia, now at £16 per ton, and containing one-third more nitrogen per ton, puts it "out of court."

As between the two sources of nitrogen, it may be said generally that, though nitrate of soda was perhaps the favourite one with farmers, they will suffer little or nothing by the enforced change. The superiority of one or the other is mainly a matter of season and of price, and, to some lesser degree, of the land and the crop. Sulphate of ammonia is a few days slower in its action, but is preferable on clay lands, just as nitrate of soda is to be chosen for chalk soils. Sulphate of ammonia is less readily washed out and so does better in a wet season, and nitrate of soda in a dry. For certain crops, *e.g.*, potatoes and sugar-cane, sulphate of ammonia

is to be preferred; for a hay crop, nitrate of soda. But, as stated, the differences between their action are not such as to interpose any real difficulty now that only sulphate of ammonia is available.

Other nitrogenous supplies will be briefly noted later, but do not exercise any real influence on the question of the moment, which, as regards nitrogen, centres upon sulphate of ammonia just as the phosphatic supply was found to hinge upon superphosphate and basic slag.

Sulphate of Ammonia.

Sulphate of ammonia, as is well known, is prepared from the ammoniacal liquors produced in the distillation of coal in gasworks and coke ovens, and from shale and ironworks, etc. A few only, and these the larger gasworks, make their own sulphuric acid from the spent oxide used in the removal of sulphur in gas purification; but the majority, and practically all the country works, purchase their acid. The smallest works of all, indeed, do not work up their liquor, but send it elsewhere.

In face of the facts recorded it is evident that it becomes a question of the highest moment that the sulphate of ammonia produced in this country should be retained, so far as our requirements go, strictly for use here. Some considerable amount is used for munitions, but what remains after this paramount need is supplied should be reserved for agricultural use. Until recently, when, on January 19th, the export of sulphate of ammonia was prohibited altogether, the question of export has been a "burning" one between manufacturers (with traders) and agriculturists.

The removal of competition in prices with nitrate of soda and the shortened supplies no doubt offered favourable inducements to export, and to this were added the advantages that the stock could be at once disposed of, the money obtained and so kept in busy circulation. On the other hand, the agriculturists and the manure manufacturers urgently required it, and, ultimately, in August 1916 the Board of Agriculture arranged with the Sulphate of Ammonia Association that farmers could obtain sulphate of ammonia until the end of September at the price of £15 per ton for immediate removal, the price for the 1916–17 season being £15 10*s*. per ton. It would appear that, previous to this, farmers had not sufficiently availed themselves of the opportunities of laying in their needed supplies. For this there were several reasons: for instance, a farmer seldom has the facilities for storing any considerable quantity of manure on his farm, and he does not care to order it long before he knows exactly what his requirements will be, while, added to this, is the expectation that prices may be more favourable. These two sets of conditions, as affecting the traders on the one hand and the farmers on the other, acted favourably to the desire for export; and it is to be noted that the total exports in July-December 1916 were only 2,900 tons less than in the corresponding period of 1915. Along with this is the significant fact that, while the exports to Spain, Holland, Java, West Indies, Japan, and the U.S.A. were less in 1916 than in 1915, and naturally more to France, there was an increased export in 1916 of 12,500 tons to "other countries" (this meaning Scandinavia and mainly Norway) over that of either 1915 or 1914. One can scarcely resist drawing the conclusions that a not inconsiderable amount of sulphate of ammonia produced in this country found its way during 1916 to countries where it should not have gone, and, further, that in the production of this a not inconsiderable amount of sulphuric acid was being used at a time when the manure manufacturers were not able to retain enough of it to make superphosphate for the farmers' needs. One may have a certain sympathy with the maker of sulphate of ammonia in that by export he turns his money over and has not to store his goods, whereas if he sells to the farmer the latter will want him to keep it for him until he is ready to use it; but in these days one ought to be patriotic, and it is not right that the only available nitrogenous manure should be sent out of the country, more especially if it has been made by using the acid of which the manure manufacturer is deprived.

Now, however, by the order of January 19th, 1917, this has been put right, the export of sulphate of ammonia being altogether prohibited, and a price of £16 per ton (£15 10*s*. per ton at the works) being fixed. While, however, expressing satisfaction at this, I must say that I do not think it would have been unreasonable to call upon the farmer to state by a certain date what his probable requirements would be, and to ensure that sufficient stock be kept over to meet these. A further matter that has been pointed out to me is that the concession to the manure manufacturer to buy sulphate of ammonia at 10*s*. a ton less is hardly sufficiently liberal to recoup him for the extra cost of handling, storing, etc.

When dealing with substitutes for super-

phosphate I mentioned that the use of nitre-cake had been urged by the Board of Agriculture on superphosphate makers. I would now ask why it should not have been equally urged upon makers of sulphate of ammonia where the product is to be used as a fertiliser? One can understand why it should not be employed when munitions are concerned, but there is no absolute need for a farmer to have a 24 per cent. or 25 per cent. ammonia "sulphate." A much lower quality would do quite well, and the presence of the sulphate of soda would not constitute a bar. I am aware, of course, that there would be difficulties with this, but probably not greater ones than exist in making superphosphate with nitre-cake, and, if necessary, the salt could be purified by recrystallisation. I have examined samples of sulphate of ammonia thus made and containing over 24 per cent. of ammonia.

Other Nitrogenous Supplies.

Of late years other forms of nitrogenous fertilisers, produced directly from the nitrogen of the atmosphere, have come into competition with sulphate of ammonia and nitrate of soda. These are "nitrolim" (calcium cyanamide) and nitrate of lime, with, possibly, nitrate of ammonia. Since the outbreak of war these, however, have not been available for fertiliser use, and so need not be considered here, though it is believed that the two former are to a certain extent being used for munition purposes.

Other nitrogenous supplies, though all limited in use and hardly entering into the present consideration, are hoofs and horns, shoddy and wool waste, castor meal, rape dust, dried blood, soot, etc., while some of the materials already named, such as bones, fish meal and Peruvian guanos, would have to be taken in respect of their phosphatic contents also. Farmyard manure, again, is the most general one, but it is hardly a saleable article, and the supply of it is, with the increase of motor traffic, a diminishing one, and now, especially with the great rise of price in feeding-stuffs, it is increasingly expensive to produce.

C.—POTASH.

Lastly comes the consideration of potash-supplying materials, and this need not detain us long, for it is well known that since the products of the Stassfurt mines ceased to come here, agriculturists have practically had to do without potash. Much has been said and written about the providing of a substitute for these salts; but, though seaweed, the ashes of hedge-clippings, bracken and other materials have been named, none of them have, except under quite local conditions, taken actual shape. Still, from time to time, materials are brought forward that supply potash, though, so far, none of them exist in any great quantity. The refuse from beet-sugar purification, the "argol" (tartrate of potash) obtained in the fermentation of wine and the sweepings of flues in works where iron and manganese ores have been smelted, are all utilised so far as they go. The last-named material has about the same amount of potash that kainit contains (10 to 15 per cent.), the potash being present partly as sulphate and partly as carbonate. It would not appear, however, that the quantity of this available exceeds 3,000 tons annually. The present price is £7 to £9 per ton, or 7*s.* 6*d.* per unit per ton of sulphate of potash. For some time there has been talk of extensive deposits of potash salts in Catalonia (north of Spain), but nothing has so far been done to develop these. Indeed, I have heard it hinted that, previous to the war, the Stassfurt people were interesting themselves in the development of this source.

Yet another supply has been heard of in potash salts of high quality, obtained by somewhat difficult refining, from districts bordering the Red Sea. These are sold on a basis of 80 per cent. sulphate of potash, and of them about 6,000 tons annually are said to be available. Peruvian guano, as already observed, contains some amount of potash, and so may acquire a special value at this time. The review of these supplies, and the fact that we are at the present time going on with our agriculture without renewing the potash supply, naturally raises the doubt as to whether the oft-preached doctrine of potash for crops has not been "overdone." Certain it is that the land is not yet suffering a potash starvation, and when I look at the Rothamsted records in the case of heavy land, and my own on light land (though carried out for a much briefer period), I confess that I fail to see the clear evidence of potash being as urgently required as has been put forward. No doubt there are certain crops such as potatoes, mangels, clover, fruit, hops, etc., which benefit largely from the application of potash, but if farmyard manure can be supplied in sufficiency it will probably give all the potash that is wanted, while for ordinary corn crops, such as wheat, barley and oats, it is very questionable if potash is required under ordinary circumstances and

in rotation-cropping. Indeed, I confess that I am beginning to wonder whether, just as with basic slag and the "citrate solubility," the need of potash for crop-growing has not, to a great extent, been the outcome of an enterprising "trade policy" rather than a truth founded on actual facts of science and practice.

However that be, I must say that I regard far less seriously than I did at first the shortage of potash salts so far as agriculture is concerned.

D.—ORGANIC MANURES.

Little need be said as to this class, the prominent members of which have already been mentioned, such as farmyard manure, castor, rape and other meals or cake residues, together with shoddy, dried blood, hoofs and horns, etc. In such times as the present, use ought to be made of all bulky organic materials which may take the place of farmyard manure, and be useful on heavy land for opening it up, and on light land for supplying "substance" and the often deficient "humus." There is, indeed, the fear that, with the confinement of manuring to superphosphate and sulphate of ammonia, the land may be found to suffer from poverty in organic matter. Sewage waste and similar refuse substances should be used wherever possible; but, of course, such materials can only be employed when near at hand, and few of them will bear carriage by rail nowadays.

E.—LIME.

I take this lastly because experiment and experience have alike told that its use is in many cases the base of rational manuring. Without sufficient lime in the land artificial fertilisers will not effect their full benefit; superphosphate used on soils deficient in lime will produce an acid condition and give rise to "finger and toe" in turnips; sulphate of ammonia used year after year on similar land will bring about, as shown in the Woburn experiments, an acid state of the soil and in process of time absolute sterility, the remedy for which is the application of lime. At the same time I may be allowed to dissent from views expressed in a recent leaflet issued by the Board of Agriculture, in which the use of lime by itself was recommended in the event of fertilisers like superphosphate and basic slag not being procurable. Lime, useful as it is, is not to be regarded as a manure, nor as taking the place of any fertiliser. It is a material for ameliorating the condition of land, and for setting free for action various fertilising constituents in the soil or applied to it; it may also be desirable, when sulphate of ammonia is freely applied, that lime be present in the soil also; but the contingency of a soil proving sterile in the course of a few years is very remote. The trouble with lime is its bulkiness, and that it is not readily procurable everywhere, while the labour of handling, carting, etc., is likely to be much felt at this time. Still, where lime is needed, it would be a most foolish policy to dispense with it.

CONCLUSION.

I have endeavoured in the foregoing to sum up the general agricultural requirements of the present time in regard to fertilisers as consisting in the supply of superphosphate and basic slag as phosphatic manures, and of sulphate of ammonia as the nitrogenous one. The others may be left to look after themselves, but the supply of these three is all essential, and if our farmers are to meet successfully the demands now made on them, it is all important that they should be put in the way of obtaining an adequate and ready supply of these. Further, now that the prices for the crops of the next few years have been fixed ahead, it is necessary that the prices of these fertilisers should not be allowed to go above a figure at which they can be remuneratively used. This the Government has, on the advice of the Board of Agriculture, wisely decided in the case of the most expensive of all, sulphate of ammonia, and it is hoped that, if found necessary, the Board will similarly intervene in the case of the other fertilisers.

DISCUSSION.

THE CHAIRMAN (Mr. Edward Packard, F.C.S.), in opening the discussion, said that with regard to the possibility of obtaining phosphates in sufficient quantities at the present time he would remind those present that in 1914 this country imported 562,242 tons of phosphate rock of different kinds; in 1915, 374,600 tons; and in 1916 only 333,371 tons —a little more than half of what was imported in 1914. In 1915 the Munitions Department of the Government requisitioned all the sulphuric acid in the country to assist in the production of munitions, and fertiliser works gave up very nearly 50 per cent. of their total amount for national use. Naturally that affected the farmers and affected the production of food in this country. Since the food question had become acute the Munitions Department had said that they would liberate some portion of the acid so that superphosphate could be produced to a larger extent. All those connected with agriculture would be

very glad of that concession, although it came late and imposed a serious difficulty upon manufacturers. Owing to the great difficulties with regard to shipping, some parts of the country had been left absolutely bare of phosphate, while other parts had been able to secure large quantities of it—more perhaps than they needed for their immediate use. The problem at the present moment was how to transfer phosphate from places where it was abundant to those where it did not exist; even coasting vessels were now difficult to obtain for that purpose, and railways had largely to be relied upon. For instance, during the last two months phosphate had been sent by rail from the west of England to the extreme east, that being the only means of obtaining a supply in the eastern counties; that involved a serious cost and took up railway waggons at a time when they were needed very urgently for other purposes. The growing of wheat in this country might be as important next year as it was in the present year—in fact, it might require to be carried out on a much larger scale, and if that were so much larger quantities of fertilisers would be required in the autumn. He did not think farmers quite realised the advantages of applying phosphatic fertilisers to wheat in the autumn, but their application then was of great benefit to the crop. In 1868, 3,937,000 acres of wheat were grown in this country, but in 1907 that had decreased to 1,665,000 acres, the large quantity grown in the former year showing what might be done now. Wheat was certainly the most useful food that could be grown, if only a sufficient acreage could be covered. But how was the increased quantity of fertilisers necessary for a greater growth of wheat to be obtained? He saw great difficulties ahead, and he doubted very much whether the importation of phosphate rock during the present year would in any way approach the importation even of last year. If the war continued—as it probably would—for some considerable time yet, it was very important in the national interests that ships should be provided to bring phosphates to this country, in order that more food might be produced. He thought the remarkable effect of basic slag upon grass land was due to the free lime which it contained, which had an especially good effect on an acid soil. On the other hand, on an alkaline soil nitrate of soda had but little effect, but sulphate of ammonia had a very good effect—an alkaline soil responded to an acid manure.

Mr. J. W. Hughes thought it would be very interesting to know how our enemies were supplied with manures. There used to be phosphates found in Germany, but he thought those had all been exhausted now. There was no doubt about the fact that German chemists were making nitrogen from the atmosphere, but were we taking any steps in that direction? He was afraid not. He hoped the time was coming when more attention would be paid to the utilising of all the refuse on farms; and we also wanted a higher system of cultivation.

Dr. Bernard Dyer said that with regard to basic slag it was quite true that the Bessemer slag, which was better known in this country than the open-hearth slag, had a marvellous effect upon grass land that did not seem to be possessed by other forms of insoluble phosphates. He did not think that effect was due, as the Chairman had stated, to the lime it contained; he thought chemists were beginning to realise that there was not the large quantity of free lime in basic slag that it was formerly supposed to possess. It was combined lime, not free lime; and effects were produced by the use of basic slag that were not produced by dressing with finely ground lime. Another point which differentiated basic slag from other forms of insoluble phosphates was the extreme readiness with which it dissolved in dilute citric-acid solution. It did not seem altogether unreasonable—in the lack of more accurate knowledge—that there was some kind of connection between those two points. The question of whether the "citric solubility" test was really the result of agricultural experiments was raised in an acute form in Germany some years ago, and as a result, at a meeting of the directors of all the agricultural experiment stations in Germany, the whole matter was remitted to each and all of the stations for re-investigation. He understood that after an investigation lasting over a few years the German agricultural chemists had come to the decision that there was no reason to depart from the citric-acid solubility test which had been maintained since the days of Wagner. He agreed with the author that sulphate of ammonia might be made from nitre-cake, and that a lower quality of sulphate of ammonia, containing a larger percentage of soda, might quite well be used by farmers. It was well known that soda had a considerable fertilising effect, and there was good reason to believe that some of the excellent effects produced by nitrate of soda on some soils were due not merely to the nitrogen but to the action of the soda portion of the fertiliser in helping to liberate potash. He believed that even nitre-cake would be very useful on some soils as an indirect means of helping to obtain potash. He agreed with the author that the value of potash had been over-estimated, as he knew of land which had received no potash dressing for twenty years, or farmyard manure or potash-containing manure of any kind, which had yet grown splendid crops of some kinds of vegetables, provided that it was supplied with nitrogen and phosphates. As regards potatoes, the non-application of a hundredweight of sulphate of potash had made in twenty consecutive years an average difference of one or two tons of potatoes an acre. Potash salts were useful in the case of

potatoes, and when they could not be obtained farmyard manure should be used, and withheld from such things as turnips and wheat, which did not need it.

MR. JOHN HUGHES agreed with the author that 2 per cent. citric acid was abnormal as an official test for phosphorus, and thought that as phosphates were likely to be used much more in the future, especially in the present year, owing to the scarcity of sulphuric acid, a much weaker solution of citric acid would be found very useful for testing the relative solubility of the different kinds of raw phosphates. With regard to the wonderful results produced by basic slag, he had come to the conclusion that they were due to the quantity of lime it contained in a very fine state of division. In ordinary slag there was from 18 to 19 per cent. of phosphoric acid, and perhaps from 40 to 45 per cent., or even 50 per cent., of lime which was in a particularly fine state of division. Further, in the samples that showed a high solubility in 2 per cent. citric acid, there was usually about 2 per cent. of caustic lime, which had a special and effective action. Some experiments were carried out a few years ago in Herefordshire by the Agricultural Organiser there, the results of which showed that finely-ground limestone, unburnt limestone but ground very fine, had a better effect than caustic lime, and he thought that supported his belief that the fineness of the grinding of the lime had a great deal to do with the success of basic slag. Now that basic slag was difficult to obtain, he thought farmers would be well advised to make greater use of lime in as fine a state of division as they could obtain it. It had been proved that some plants would take up lime in place of potash.

MR. W. A. COX thought the author should have referred to the use of basic slag in the case of root crops and potatoes, etc., in which connection it was very little inferior to superphosphates, as had been shown by experiments carried out by the Department of Agriculture in Ireland. With regard to the citric-acid solubility test, the results of experiments carried out during the last few years had shown clearly the superiority of high citric-acid soluble slags over slags of low solubility, but unfortunately those experiments had not yet been published. He did not mean to indicate, however, that there was no value in low soluble slag. Further, the results of experiments carried out in Germany, as Dr. Dyer had remarked, showed clearly that there was no reason whatever for departing from the citric solubility test. With regard to the Chairman's statement that the good effects of basic slag were due to the presence of free lime, he would like to remind him that in various parts of England and Scotland superphosphate *plus* ground lime in combination had been tested against basic slag alone, and without exception the results had been in favour of the basic slag. He wished to emphasise the point that basic slag had an excellent effect not only on grass land when applied in the autumn, but also on the root crops and the potato crops when applied at the time of drilling the seed and planting the tubers respectively.

MR. WALTER F. REID differed from previous speakers by holding that it was the soluble silica in basic slag that produced the good results on corn and other crops. When he was making Portland cement, the dust from the factory used to be blown over to certain areas of grass land, and in those places the grass always improved. There was no phosphoric acid at all in the Portland cement he was then making. He thought considerable quantities of basic slag could be obtained at the present time; a very large amount of steel was being made, and every ounce of steel meant a quantity of basic slag. There was not very much potash in this country, but there were deposits of it in Alsace superior even to those at Stassfurt, and if, as was to be hoped, Alsace reverted to France after the war, some of that supply would in all probability be available for this country. With regard to nitrates, the air around us contained the material to produce exactly what farmers wanted, and something was now being done in that direction. In 1906 he was a member of a deputation to Mr. Lloyd George, then at the head of the Board of Trade, with regard to the compulsory working of patents in this country, and he then said that it was quite useless to have a patent if the industry in connection with it was not to be established in this country, for then we should not produce the material required to keep the enemy from our doors. He wished to point out to the author that the bulk of the nitre-cake, supplies of which were available at the present moment, was made from the manufacture of nitric acid, and not in the way the author had indicated.

MR. ALFRED AKERS agreed entirely with the author as to the value of chemical manures. He had the greatest faith in superphosphate for wheat, and he was pleased to hear the author say that it should be put on in the autumn. During the war he had quadrupled his area of wheat, and he invariably put on a good dressing of superphosphates just before the wheat was drilled. With regard to the author's remark that a greater production of food in this country could not be obtained without the use of fertilisers of some kind, he ventured to say that one way by which the food production could be increased was by getting back a larger proportion of grass land into arable land. In Germany the land was something like two-thirds under the plough and one-third grass, whereas in this country it was just the other way about. Land which was under grass for a good many years accumulated a great quantity of humus and other things which constituted an admirable manure for either corn or root crops which might succeed the grass, and he did not agree that that land would require immediately any large quantity of chemical manure.

The two great difficulties were time and labour, but he thought it was of the utmost importance that more of the land in this country should be under the plough.

Mr. H. Trustram Eve thought farmers were inclined to use much more artificial manure at the present time than they used to do, but they were met with the difficulty of how to obtain it. They wanted to know whether they could get certain manures, and, if so, where—price was a secondary consideration. People frequently wrote to him asking those questions, and he advocated the establishment of a Bureau of Information to deal with them. Basic slag in large quantities would be required by farmers in the spring, in view of the increased quantity of food that was demanded from them. Labour in connection with basic slag had now been made a reserved occupation, but even so that industry was suffering from a great shortage of labour. He suggested that a leaflet might be issued saying exactly what could be done for the 1917 crop in the way of manures, and if the farmers could not be supplied with them they had better concentrate their attention on lime or soot; on some lands even salt was better than nothing. He did not think farmers ought to be blamed at the end of the year for not having used more manure, in view of the great difficulties they experienced in obtaining it.

Mr. A. E. Strong, as a manufacturer of fertilisers, said he was sorry he could not give any satisfactory answer to Mr. Trustram Eve's questions. The manufacturers themselves wanted to know whether they were going to have more phosphates, how much acid they were going to obtain, how long their present very much depleted labour staffs would be left to them, and so on. He thought farmers who were really alive to the necessity for fertilisers would have obtained them a month or two ago, and that any farmer who was now looking about for some superphosphate or basic slag would find he had to go without. Even so, however, a crop grown without manure would be better than none at all.

Dr. George McGowan said that there were very large stocks of nitre-cake and low-grade phosphates in this country, and he thought they ought to be utilised. With regard to potash, there were various sources from which that substance could be obtained, one being a green sand in a very fine state of division, and another the waste products from wool-scouring works in Bradford and elsewhere.

Mr. W. E. Oakden wished to ask the author whether it was absolutely necessary that the ammonia produced in gasworks should be converted into the sulphate. Could it not be utilised in some other form, and the sulphuric acid necessary to form the sulphate of ammonia be utilised for the purpose of producing the superphosphate?

Mr. George V. Parker said that, with regard to the remark of Dr. Dyer that very little was known in this country about the open-hearth process, there were at the present time only about four Bessemer furnaces in this country, the remainder being the open-hearth or basic processes; therefore he thought we knew a great deal about the open-hearth slag. There were firms in this country now willing to grind the low-grade basic slag, and they were only waiting for a little encouragement from the Board of Agriculture. When that was forthcoming they would go ahead, and there would be something like 180,000 to 200,000 tons of slag available in this country. He anticipated that next year there would be at least 150,000 tons of slag available for use here which were not available last year or in the previous year, owing to the Board of Agriculture having previously given licences for export to anyone who asked for them.

On the motion of the Chairman, a hearty vote of thanks was passed to the author for his very interesting paper.

Mr. J. A. Voelcker, in reply, said he was sure everyone realised that manure manufacturers had dealt loyally with the nation in the present time of crisis. He thought the various remarks that had been made about basic slag proved his contention that basic slag was a thing nobody as yet could understand. He was not satisfied that the results of experiments up to the present at all bore out the value that was attributed to the citric-solubility test. With regard to obtaining nitrogen from the atmosphere, this country ought long ago to have turned its attention to that subject. He thought the value of turning grass land into arable land depended very much on the kind of grass land that was converted. It was not likely that people would use their best grass land for that purpose—if they did they would not want good fertilisers; but with the poor kinds of grass land that would probably be used fertilisers would certainly be wanted. In reply to Mr. Oakden's question, it was certainly not necessary that gasworks ammonia should be made into sulphate of ammonia.

Mr. Mateo Clark writes:—I think it important that certain erroneous reports as to the approaching exhaustion of the nitrate supply should be contradicted. Surveys were made in various parts of Chile, and in 1911 it was ascertained that there existed 200 million tons of nitrate capable of being profitably extracted, and as the largest amount exported recently has been about 3 million tons per annum, at this rate there would be enough for about seventy years. These figures, it should be borne in mind, refer only to the last surveys made, but there are still very large tracts of the same class of ground not yet surveyed, and in the opinion of experts there is no reason why there should not exist in the country as good, or even better, beds of nitrate. These unexplored lands are of such extent that it is believed that at least four or five times more than the quantity so far ascertained

may exist for future extraction. It is therefore estimated that the supply of Chilean nitrate will not be exhausted for at least two hundred years, even at an increased rate of production. Improvements in the process for extracting the nitrate from the "caliche" are being introduced with the object of reducing the percentage of loss, which has hitherto been rather high.

EDUCATION IN TECHNICAL OPTICS.

A valuable report on this subject was lately issued by a committee* of the Board of Scientific Societies. The text of the report, which has been circulated, but not yet, we believe, otherwise published, will be found, with some introductory comment, in *Nature* of March 1st.

The report refers to the scheme put forward by the London County Council, but does not entirely agree with it, and, after pointing out the importance of a definite organisation of instruction and research in optics both as regards the needs of the optical industry and the requirements of Government departments, it proceeds to indicate the means by which such organisation could best be provided. Ultimately the Committee look forward to "the establishment of an optical institute which would concentrate the efforts of all who are concerned with the manufacture or use of optical instruments. It would bring together the several optical societies, which might find a home within its building; it would be the centre for the co-operation of the trade with students and teachers; it should contain a library with periodicals and books on optics."

The general direction of the courses of study would be invested in an advisory council on which the trade, as well as the optical and learned societies, would be represented. There should be a principal or director qualified on both the theoretical and the practical side. Full courses of instruction, in both day and evening classes, will be required.

The work would be adapted to the requirements :—

1. Of students engaged in the trade.
2. Of advanced students.
3. Of other persons interested in learning the scientific construction or use of optical instruments.

Provision should be made for research work not requiring a highly specialised or expensive plant. Special investigations might be referred to the National Physical Laboratory, or any other laboratory suitable for the purpose.

Inasmuch as it would probably be a considerable time before so complete an institution could be organised, the committee conclude their report by a summary of the requirements which appear to them to require immediate attention :—

1. The appointment of a supervising representative council.
2. The appointment, under the proposed supervising council, of an administrating director, with special duties during the transitional period, which will include advice to the trade and the organisation of the different parts of the curriculum.
3. The translation of suitable works and the abstracting of other important publications on technical optics.
4. Pending the erection of a suitable building, the organisation of day and evening courses at the Northampton Institute, and arrangements for higher instruction at some other institution of university rank.

* Mr. Conrad Beck, Mr. F. J. Cheshire, Mr. E. B. Knobel, Sir Philip Magnus, Professor H. Jackson, and Professor A. Schuster (chairman).

ENGINEERING NOTES.

The Panama Canal.—The channel in the cut, says the *Panama Canal Record*, is in better condition now than ever before. The central cut through which the vessels pass, known as the sailing channel, has a minimum depth of 33 ft., and the least width of a channel of 30 ft. depth is 180 ft. This is opposite the rock known as "Gibraltar," at the foot of the East Culebra slide. This rock extends into the channel about 110 ft. from the prism line, for a distance of about 220 ft. along the axis of the canal, from station 1792 to 1794. At other parts, between the Culebra slide and at Cucaracha slide, the channel has been dredged to at least 30 ft. for the full width of 300 ft. between the prism lines. The dredgers Corozal and Paraiso are at work in the slide area. They are working close to "Gibraltar," removing the rock itself and cutting in behind it to prevent its being pushed forward. A number of drills are engaged every day, including Sundays, on the work of drilling and blasting the rock for the dredgers to remove it. It has been considerably reduced in size, and now extends only about 30 ft. above the surface of the water in the cut. The smaller dredgers have been withdrawn, because only a few can work to advantage in the area to which dredging is now confined, and the large dredgers can operate less expensively. Recent events seem to show additional reasons for the American Navy to make the interoceanic traffic as easy as possible.

The Channel Tunnel.—This tunnel, for which many schemes have been discussed by the Royal Society of Arts, now appears in a new light in reference to the present war. Sir Francis Fox, M.Inst.C.E., of the firm of the engineers who have prepared plans for the work, makes some interesting remarks in an article contributed to the *Revue Franco-Étrangère*. In this he says: "It is hardly necessary to call attention to the enormous value of such a tunnel had it existed during the two years of this great war. It defies all calculation as to what the saving in

suffering and in cost would have been. Every soldier, every horse, every pound of ammunition, all the guns, the vehicles, and nearly all the food have had to be carried across the Channel at prodigious expense. The armies of labourers in the docks of both countries, the long lines of ships carrying and discharging horses, timber, petrol, fodder, coal, coke, and rations, would not have been required. The military gain of being able to transport, without change, troops from our great camps, material of war from our factories, and to bring back the sick and wounded with the minimum of suffering and fatigue, would have been beyond all measure, while the release of our Navy from the arduous task of protecting the Channel waterway would have represented a saving probably of scores of millions sterling. It is, therefore, quite safe to say that the entire cost of the tunnel—£16,000,000—would have been paid for over and over again." However, according to the isolation theory of partisans and to some of the military advisors on the subject, the strange corollary inevitably follows, that if the suppositious tunnel had been constructed before the war took place it should be demolished on the declaration of peace.

Sun-power in Africa.—In a somewhat optimistic address on the coal resources of the United Kingdom, delivered recently at Cardiff by Professor Arnold Lupton, he included, though wide of the immediate subject of the paper, the matter of sun-power. He said that sun steam-engines have now been made on a practical scale, and one of fifty horse-power has been erected in Egypt at Maedi, near the River Nile, not far from Cairo, for the purpose of pumping water for irrigation. In these works there is considerable concentration of the sun's rays by reflectors, and the steam is used at a pressure only slightly above that of the atmosphere. Of course, with a low-pressure engine it is necessary to have a very good vacuum, and therefore a good supply of cold water for condensation. It therefore follows that, if the sun's power is used for heating steam boilers, these must be in some situation where it is possible to obtain a large supply of cold water for condensation at a moderate cost, and therefore, if a large power is required, they must be not too far from some great river or large lake or the sea. Owing to the low pressure at which the steam is used, there need not be much escape of steam, and consequently the loss of water need not be very large. Mr. Lupton continued: "There are, however, enormous areas of sun-burnt desert in Asia, Africa, America and Australia where the mighty power of the sun is in evidence almost every day, where sufficient condensing water could be obtained at a moderate expense over many millions of square miles." Although steam has been already generated by sun-power at Meadi at a speed equivalent to 200 b.h.p. per acre, and although if there were a large demand for sun-power boilers no doubt they would be greatly improved still, Mr. Lupton has taken the average power all the year round in the country between Cairo and Khartoum as being, say, 50 b.h.p. per acre. At that rate 1,000,000,000 b.h.p. could be generated from 20,000,000 acres, or, say, 30,000 square miles; so that it is not likely that the human race will ever require 1 per cent. of the available sun-power. It must, however, be borne in mind that the area of land immediately under the equator is comparatively small, and that there is considerable rainfall in that area. The dry places are from 20 to 30 degrees from the equator, and therefore the sun-power on any particular boiler will vary greatly with the seasons. But if the sun-power is in the Sahara Desert, what use is that to the people of the United Kingdom? The answer is that this power can be transmitted electrically at a very moderate cost, as may be shown. The professor then goes into the necessary calculations and data, which amount to this result—the cost would be, from the Sahara Desert to the United Kingdom, including interest on capital and working expenses, 0·36 of a penny per kilowatt hour. The cable carrying the power would deliver current in Spain and France on the way, and this would reduce the average length of the circuit.

The Marconi Vacuum Ampere Gauge.—The demand for a small, sensitive, robust instrument suitable for use equally on alternating and continuous current is not new, and inventors have made many attempts to satisfy it. It has remained, however, for the Marconi Company to produce just what is required, and a great demand for the new gauge is anticipated. The instrument is designed primarily as a maximum current gauge to indicate the condition of syntony in wireless circuits, and may be employed as a substitute for a thermo-junction and galvanometer combination in the measurement of wave-lengths and decrement. The principle involved is that of the bifilar suspension, one pair of the filament ends being fixed, and the other pair attached to a pivoted arm, the rotation of which is controlled by a spring acting against the tension of the filaments. When a current passes through the filaments, heating them and causing them to elongate, the arm takes up a new position, and the angular displacement as indicated on the scale is a measurement of the current. The movement is enclosed in a glass bulb exhausted of air. The sensitiveness is thus greatly increased, and the movement protected against damage and preserved from dust or corrosion. Readers who are acquainted with practical wireless work will realise that the instruments are likely to prove of the greatest service, not only in radiotele-

graphy, but in all practical application of electricity. The above particulars have been abridged from an article in *Wireless World* for February, in which the illustrations supplied afford much information of a detailed kind.

OBITUARY.

JOHN HOUGHTON MAURICE BONNOR.—Information has been received of the death of Mr. John Houghton Maurice Bonnor, which took place in New York on January 29th. Mr. Bonnor went to Ottawa last year to carry out the internal and external decorations of the new Parliament House.

He was born in 1875, and educated at a private school in Rhyl. For some time he worked in the office of Messrs. Young and Hall, architects, and subsequently in the architect's office of the London County Council. He then started as a craftsman, at first with the Artificers' Guild, and afterwards in his own workshop. He was an artist of much versatility, and worked in a great variety of materials, including jewels, metals, enamels, stained glass, mosaic, sculpture, and wood. At one time he held a class for jewellery at Camberwell School of Arts, and latterly at the Central School.

His work was well known and admired by a large and increasing circle, and his early death has cut short a career of unusually brilliant promise. Amongst his most important productions may be mentioned the stained glass heraldic panels at Balliol College, Oxford, and Caius College, Cambridge; the stained glass window in the church of St. Michael and All Angels, Turnham Green; the figures of Christ, St. Mary and St. John at St. Mary's Church Bermondsey; the large rood-beam in carved wood at St. Joseph's Church, Aldershot; a number of memorial tablets, pieces of church furniture, caskets, jewellery, etc.

He was elected a member of the Royal Society of Arts in 1906.

GENERAL NOTE.

HYDRO-ELECTRIC POWER IN CANADA.—Hydroelectric power has played a most important part in the industrial development of Canada. Within the Dominion, excluding the North-West Territories, practically all of the Yukon, and the northern and eastern portions of Quebec, it is estimated that nearly 17,750,000 h.p. are available. The actually developed power, whether for electrical production, pulp-grinders, milling or the many other uses, aggregates 1,712,193 h.p. Of this the highest figure is in Ontario, 789,466 h.p.; Quebec comes second with 520,000 h.p.; and British Columbia third with 265,345 h.p. Practically the whole of this power has been developed within the last twenty years, while about two-thirds of the total has been produced in the last decade.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 21.—G. W. JONES, "Colour Printing, and some Recent Developments." CARMICHAEL THOMAS, Chairman of the *Graphic* and *Daily Graphic*, will preside.

APRIL 18. — HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

APRIL 25.—SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

MAY 2.—J. C. SHENSTONE, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future."

MAY 9.—PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

INDIAN SECTION.

At 4.30 p.m.:—

TUESDAY, MARCH 27. — SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India."

THURSDAY, APRIL 19.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

Date to be announced later:—

D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m.:—

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

Dates to be hereafter announced:—

SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

JOSEPH PENNELL, "The Artistic Aspects of War Work."

Aldred Lecture.

Monday afternoon, at 4.30 p.m. :—

Lawrence Weaver, F.S.A., "Memorials and Monuments." Three Lectures.

Syllabus.

Lecture III.—March 19.—Equestrian figures—Group memorials—Public school, regimental and civic monuments—The War memorial—Teuton *versus* Latin spirit in design—The Christ of the Andes — Columns and arches — Buildings and bridges—Monumental art and town planning.

Howard Lectures.

Monday afternoons, at 4 p.m. :—

William George Fearnsides, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 19...Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. (Aldred Lecture.) Mr. L. Weaver, "Memorials and Monuments." (Lecture III.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. General Sir Charles Warren, "The Significance of the Geography of Palestine."

Bibliographical Society, 10, Hanover-square, W., 5 p.m. Dr. E. Gosse, "The Posthumous Writings of Swinburne."

Geographical Society, Burlington-gardens, W., 5.30 p.m. Dr. E. W. G. Masterman, "Palestine: its Resources and Suitability for Colonisation."

Tuesday, March 20...Statistical Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.15 p.m. The Earl of Dunraven, "How to Improve our Fishing Industries."

Petroleum Technologists, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Dr. F. Mollwo Perkin, "Sulphur in Petroleum Oils."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. W. Gregory, "Geological War Problems." (Lecture II.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. E. M. Lacey, "The New Electric Power-house at Birchills, Walsall."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Dr. C. A. Swan and Mr. A. Coburn, "Colour-Sensitive Plates."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. E. P. Allis, Jun., "The Prechordal Portion of the Chondrocranium of *Chimæra colliei.*" 2. Mr. D. M. S. Watson, "A Sketch-classification of the Pre-Jurassic Tetrapod Vertebrates."

Wednesday, March 21...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Mr. G. W. Jones, "Colour Printing and Some Recent Developments."

Aeronautical Society of Great Britain, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. H. Thomas, "Commercial Aeronautics."

Meteorological Society, Caxton Hall, Westminster, S.W., 5 p.m. Major G. I. Taylor, "The Formation of Mist and Fog."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Professor Sir Thomas Oliver, "The Hygiene of Occupation in War Time."

Microscopical Society, 20, Hanover-square, W., 8 p.m. Mr. K. Goadby, "Bacteriology of War Wounds."

Electrical Engineers, Institution of (Local Section.) 17, Albert-square, Manchester, 7 p.m. Mr. L. Leighton, "Equipment of Hull Joint Docks."

(Yorkshire Local Section.) Philosophical Hall, Leeds, 7 p.m. Mr. G. A. Juhlin, "The Voltage Regulation of Rotary Converters."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. L. Courtney, "Mr. Thomas Hardy and Æschylus."

Metals, Institute of, at the Chemical Society, Burlington House, W., 8 p.m. Annual General Meeting. 1. Mr. O. W. Ellis, (*a*) "The General Properties of Stampings and Chill Castings in Brass of Approximately 60/40 Composition"; (*b*) "Machining Properties of Brass." 2. Mr. S. W. Smith, "Surface Tension and Cohesion in Metals and Alloys." 3. Dr. R. Seligman, "Aluminium Production by Electrolysis: A Note on the Mechanism of the Reaction." 4. Dr. F. C. Thompson, "Annealing of Nickel Silver." (Part II.)

Thursday, March 22...Geographical Society, Kensington-gore, S.W., 5 p.m. Dr. J. Ball, "Modern Methods of Finding the Latitude with a Theodolite."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Metals, Institute of, at the Chemical Society, Burlington House, W., 4.30 p.m. Annual Meeting (continued). (1) Mr. W. J. Hocking, "Metal Melting as Practised at the Royal Mint." (2) Mr. G. B. Brook, "Coal Gas as a Fuel for the Melting of Non-ferrous Alloys." (3) Mr. C. M. Walter, "High Pressure Gas Melting." (4) Messrs. H. M. Thornton and H. Hartley, "Contribution to Metal Melting Discussion." (5) Drs. H. C. Greenwood and R. S. Hutton, "An Electric Resistance Furnace for Melting in Crucibles." (6) Mr. C. Hering, "Ideals and Limitations in the Melting of Non-ferrous Metals." (7) Mr. H. S. Primrose, "Metal Melting in a Simple Crude Oil Furnace."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. A. Fleming, "Modern Improvements in Telegraphy and Telephony. Lecture I.—Telegraphy."

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. H. Garrison, "New Zealand: the Wonderland of the World."

Electrical Engineers, Institution of, Victoria-embankment, W.C., 8 p.m. Mr. F. R. McBerty, "Machine Switching Telephone Gear."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Mr. W. Cleaver, "The Rational Design of Reinforced Concrete Wharves and Jetties, with particular reference to those for Wet Docks having a permanent Water Level."

City of London College, White-street, Moorfields, E.C., 5.30 p.m. Mr. C. J. Tabor, "Some Notes of the Damage to which Refrigerated Foods are liable."

Ladies' Alpine Club, 23, Savile-row, W., 8.15 p.m.

Friday, March 23...Royal Institution, Albemarle-street, W., 5.30 p.m. Mr. E. Clodd, "Magic in Names."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Saturday, March 24...Royal Institution, Albemarle-street, W., 3 p.m. Mr. S. Graham, "Russian Idealism—The Russian Madonna." (Lecture I.)

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Journal of the Royal Society of Arts.

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FRIDAY, MARCH 23, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

TUESDAY, MARCH 27th, at 5 p.m. (Indian Section.) SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India." Owing to the absence of the author in India, the paper will be read by Surgeon-General Sir R. Havelock Charles, G.C.V.O., M.D., F.R.C.S.I., President, Medical Board, India Office. The RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, will preside.

ALDRED LECTURE.

On Monday afternoon, March 19th, Mr. LAWRENCE WEAVER, F.S.A., delivered the third and final lecture of his course on "Memorials and Monuments."

On the motion of the CHAIRMAN (Mr. Alan S. Cole, C.B.) a vote of thanks was accorded to Mr. Weaver for his interesting course.

The lectures will be published in the *Journal* during the Summer recess.

PROCEEDINGS OF THE SOCIETY.

FIFTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 21st, 1917; CARMICHAEL THOMAS, Chairman of the *Graphic* and *Daily Graphic*, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Chatterjee, Atul Chandra, I.C.S., 15, Eaton Rise, Ealing, W. (5)

Watson, Ralph Douglas, 12, Tankerville-terrace, Newcastle-on-Tyne.

The following candidate was balloted for and duly elected a Fellow of the Society:—

Ledgard, Sir Henry, Langdale, Farnham, Surrey.

The paper read was—

COLOUR PRINTING, AND SOME RECENT DEVELOPMENTS.

By G. W. JONES.

When the Royal Society of Arts did me the honour of asking me to read a paper on colour printing by what is known as the three-colour process, I pleaded that the ground had already been so well covered by students, workers, and technical writers, that I should be in danger of finding myself in the position of Canning's knife-grinder, who had "no story to tell."

It was suggested, however, that I should treat the subject from the point of view of personal contact with the process from about 1893—first in experimental work, and subsequently in the commercial production of large quantities of colour printing. The desire was expressed that I should give some account of my experimental work in connection with the "Renaissance" method of intaglio offset printing, and it was more than hinted that I ought to be able to offer an opinion on how best to combat the Continental competition from which British colour printers by various methods have suffered in the past. In short, I was confronted with the task of reviewing from the national standpoint an important branch of my own particular industry, and of setting forth briefly my opinions on colour printing after the war.

An audience such as this, more or less intimately acquainted with photo-engraving and printing processes, will not require at my hands lengthy historical details of the rise and progress of three-colour printing in the British Isles. As practical men themselves, my hearers will naturally expect me to present them with the facts of practical experience rather than theories and historical generalities; yet, for the sake of lucidity, I find myself obliged to resort in the first place to the narrative form.

Colour printing from photo-engraved blocks,

as now and for the past twenty years in general use, was rendered possible about 1885–86 by the introduction of the cross-lined half-tone screen. It cannot be stated with certainty who produced the first English three-colour print issued commercially, but the honour is claimed on behalf of Messrs. Waterlow and Sons, who, in February, 1892, produced, as a supplement to *Land and Water*, a plate representing the Derby winner of 1890. By the courtesy of Mr. R. A. Peddie, librarian of the St. Bride Foundation Typographical Library, I am permitted to show this picture, with the progressive workings. It was produced under the superintendence of Mr. J. D. Geddes, a well-known practical photo-engraver, and a competent authority on the method.

The first supplement by the process to appear in the *British Printer*—a still-life subject—is to be found in the September-October number of 1893. The blocks were made by Husnik and Hausler, of Prague. About the same time supplements printed from chromotype blocks followed in quick succession—for British process-engravers applied themselves with zeal to colour reproduction—but no other specimen by the three-colour process appeared in the *British Printer* until the autumn of 1894, when a reproduction from a xylographic woodcut—evidently by the Knöflers, of Vienna—and its progressive workings were shown.

Aided by improved methods and more perfect filters, engravers at last touched the solid ground of the scientific process of photographic reproduction. Their efforts were heartily seconded by enterprising printers, who welcomed three-colour work as a new avenue of employment, and hastened to provide themselves with the requisite plant.

For a long time, I fear, the colour engraver was looked upon as the poor relation of the printing family. Twenty years of praiseworthy enterprise have placed him in the position of an equal. So certain does he feel his position to-day that his ability to make conditions is the envy of his printer colleague.

My own practical connection with the process began in 1892, when the late Mr. John Swain, jun., of the celebrated engraving house—for whom I had produced much half-tone printing—provided me with colour blocks for experimental purposes. We worked in collaboration for a time, and two of our earliest efforts are exhibited here.

Afterwards I printed "War Impressions," by Messrs. A. & C. Black, of Soho Square—the first book to be illustrated by the three-colour method—which appeared in 1903.

"Nice customs curtsy to great kings," and surely those who complain most loudly about "the mark of the beast" in the screen dot, and lament the inartistic appearance of colour work on coated paper, may forgive much to a levelling process like three-colour, which places the humblest almost on an equality with the rich in the matter of reproductive art. One might imagine that these grumblers object to art being "commercialised," as they style it, not because commercial art is vulgar, but because it is cheap.

The three-colour method is in general use, not only for colour reproduction of pictures and drawings, but also by the commercial world for the illustration of natural products and of manufactures of almost every kind. Science has followed suit, and it would be difficult to specify any form of human endeavour depending for success upon truthful colour presentation which has not benefited by this important development of letterpress printing.

The conductors of the best illustrated newspapers, who have moderated their enthusiasm since the outbreak of war, were among the greatest fosterers of three-colour printing for the brightening of their pages, while many of their most progressive advertising clients resorted to its use for more effective advertisement. It may here be remarked in parenthesis that the recent issues of the principal illustrated weekly newspapers published by our chief enemy show no diminution in the amount of colour work they contain.

If the three-colour process is not yet considered an essential trade or calling, it has woven itself into the web of our commercial life.

Probably every member of my audience will agree with the Ruskinian dictum that "every rightly-constituted man loves colour." To attempt to question it would be equal to "speaking disrespectfully of the Equator." But even the most enthusiastic must allow for difference of opinion, and it may be conceded without a murmur that, unless the colour be good, black or monochrome is preferable. When colour is good and justifiable, it is because it is a faithful reproduction of the original. When it is bad, it is a crime—for the double reason that it is an offence by the perpetrator and a degradation of the original.

It may be mentioned here that surface-coated papers, suitable for receiving and retaining the nicest shades of the photo-engraved plate, had previously been supplied to meet the demands of half-tone monochrome printing.

These required little adaptation for colour blocks by the same method of engraving, and from the printer's point of view met the case more or less completely; but readers justly objected to the weight of the coated paper, to the feeling of repulsion which it induces on touch, and to its liability to adhesion from contact with moisture.

The best results in printing from half-tone blocks, whether in one or more colours, are obtained by the use of a press combining rigidity of impression and perfect rolling power. The ideal impression is that of firm contact, just sufficient to lift the ink from the plates, and not squeeze or extreme pressure, which is fatal to good work. The demand for improved presses to print the heavy woodcut work previously used freely in American catalogues and similar productions had been responded to by American press manufacturers; and for the purposes of the new half-tone printing, British printers gladly availed themselves of platen and cylinder machines imported from the United States. They were thus enabled to grapple with the three-colour process fortified by experience in the make-ready and printing of half-tone blocks on specially-designed presses which possessed in addition the necessary advantage of accurate register. English machine manufacturers were not at this time quite awake to the needs of the hour, but when they realised the possibilities of the new development they endeavoured to rise to the occasion, and many improved machines were turned out. I may return to this subject later.

The three-colour block thus found the clay-coated paper, the heavy platen press, and the two-revolution machine ready for its advent. To render it a commercial success suitable inks and competent workmen were also necessary.

Taking first the matter of coloured printing inks, it is common knowledge that, when the new process was introduced, Germany supplied a great part of the dry colours used by British printing-ink makers, as well as a large amount mixed ready for use, which went direct to the printer.

The British printing-ink manufacturer was as keen as the engraver and the printer to appreciate the importance of the new printing method, and the demands it was likely to make on his resources; and if to-day, when free access to the principal source of supply of the raw material is closed to him, we are experiencing but a moderate amount of difficulty in meeting our requirements, it is owing to the grit and grip with which, against great odds, the home manufacturer has contended for a considerable number of years.

His position was pretty well as unenviable as that of the British printer. The latter had to meet a competition as unfair as it was insidious and persistent. He was practically obliged to go to Germany or America for one build of press, as well as for much of his coloured inks in their manufactured state, and was required to quote against scientifically equipped German competitors, who were paying only some 75 per cent. of the wages paid in England for a similar output of work. The British printing-ink manufacturer at the same time was dependent largely on the German manufacturer for his dry colours. Some of the German printing-ink manufacturers employ in their laboratories colour chemists of European reputation, with a considerable number of assistants, who are able to devote all their time and accomplishments to research and experimental work without the distraction of the commercial side of the business.

Surely if any process of manufacture requires the utmost aid of science, the production of coloured printing inks calls for the employment of skilled chemists possessing a special knowledge of the testing of pigments in all their phases as to their suitability for this manufacture, as well as skill in the mixture of the pigments with the vehicle and other ingredients which go to make printing inks suitable for the finest colour work.

Too much, if we may judge from experience, has been left to the foreigner in this most important department. The business is sufficiently large and important to justify the assistance of the best scientific chemists that this country can produce.

If the aniline dye industry can be reconstituted in England, there is reason to hope for the future independence of ink maker and printer in this particular.

As to the printing machineman, the last link in the chain of production, the younger workmen of the British machine-rooms responded readily to the new demand on their patience, skill and thoughtfulness, and, given proper facilities and conditions, proved themselves able to hold their own with Continental competitors.

A good eye for colour is as essential to a printing machineman as careful make-ready and exactness of register. Another requisite is that the printing machineman should, if possible, be allowed to specialise in colour work. If it can be avoided, it is undesirable to give men alternating formes of black and colour. The

minder, on his part, can do much to qualify for specialising by the study of colour both in nature and in art. The best engraved block may be rendered nugatory if treated unsympathetically in the machine-room.

Controversy has always raged as to whether three or four blocks give the best result in colour-printing, *i.e.* as a general principle, especially because purer primary colours may be used. Were the system to be standardised one would unquestionably favour the four printings. This judgment is justified by the practice in the United States, France, and Germany. In Great Britain, however, the printer's preference is too often hindered by considerations of price, and four-colour workings are less often resorted to than three.

There are, perhaps, instances in which the three colours give the better, or perhaps the most transparent, result.

By the kindness of Messrs. A. & C. Black I am permitted to show progressive workings and finished print from a set of small three-colour blocks of "The Bird's Nest," photographed direct from the original drawing by Birket Foster.

The reproduction is exactly the same size as the drawing. The blocks were made at Watford under my direction. In this case I am of the opinion that an additional block would not have improved the picture.

About the same time Messrs. Black wished me to produce three-colour blocks for the printing of some threescore Morland pictures. I could not admit that it was possible in this instance to obtain in three printings the high standard of colour-faithfulness desired. The matter was tested by the preparation of one set of three colour blocks, when it was demonstrated that four printings were necessary. In this case I did not find the use of the three primaries and black quite satisfactory, although theoretically they should have been the best to use. Finally, by proofing two sets of blocks in several different sets of colours, in the endeavour to get the strength and tone which is generally apparent in the paintings by that master, we arrived at a result which approximated closely to the pictures and proved satisfactory to all concerned. We used the same series of colours throughout, in order that a large number of plates could be printed together on one sheet.

In the large framed reproduction of "The Fortune Teller," by Morland, which is shown here, I have used a grey tint in addition to the four colours. The picture was photographed direct from the original in the National Gallery. The other three Gallery pictures—"The Infant Samuel," Turner's "Venice," and Mrs. Robinson ("Perdita") after Romney—were all reproduced direct and printed in four colours. In each case, except that of the portrait of Mrs. Robinson, which was inaccessible, several visits were made to the Gallery for the purpose of comparison with the subject, in order to ensure fidelity to the colour of the original picture.

The four Thorburn reproductions, and those of motor-cars and dental chairs, were all produced by the four-colour method.

In the case of the Oriental china prints, one extra green plate was made for the Famille-Verte vase plates; and an extra blue was used in the plate showing a pair of blue vases. These plates were reproduced direct from the original china ware in their London home.

The large sheets, showing the progressive workings of a sheet of book illustrations, are exhibited to show that no insuperable difficulty is found in printing a sheet of comparatively large size containing a number of blocks.

I trust the work by this process will be deemed sufficiently representative to demonstrate the wide applicability of this simple and natural method of printing from photo-engraved blocks, and the universality of its usefulness.

Perhaps it is fitting that I should state here that that usefulness has been enormously advanced by the ability of the printer to procure duplicate plates from his original engraved blocks — duplicates so faithful in all printing respects to the half-tones that, when printed with the original plates, it is impossible even for the skilled printer to distinguish them with any degree of certainty.

The great improvement in the manufacture of printers' rollers, both in composition of materials and method of casting, has helped materially in making this method of printing a thoroughly commercial one.

One imperfect roller may mean ruin to the perfect printing of a colour job which, in the various manufactures and operations which go to the complete work, may have called for the co-operation of hundreds of workers.

I have referred generally to the principal necessities of the colour printer (if he is to produce work of excellence), such as the press or machine, the paper generally used, inks and rollers. The many other accessories and lesser necessities vary according to the nature of the

work. Such an apparently simple matter as interleaving paper calls for great care in its selection. Prime considerations, however, are those of heating and lighting. All other conditions may be perfect, but without good lighting, and especially the ability to maintain a sufficient and even temperature, you will be dogged with difficulties.

The half-tone method of illustration has much to answer for as the principal agent in the displacement of wood-engraving, which for centuries was the chief method employed for book illustration, and for years immediately previous to the advent of the photo-mechanical process had been very extensively used for commercial purposes. Many lovers of the beautiful handicraft still cherish resentment towards the photo-engraver. A like feeling has called forth expressions uncomplimentary towards the workers and advocates of three-colour printing. With its advent the days of chromo-xylography were numbered, but few tears were shed over its funeral.

It cannot be hoped that the atmosphere and opportunities of the engraving departments called into being by the new means of colour reproductions will be fruitful in the production of artists of great ability, such as have graduated from the engraver's studio and the lithographic shop. Many instances of such inspirations and encouragements are recorded. The painter of delightful English country scenes and English children, a reproduction of whose sweet little drawing of "The Bird's Nest" is in your hands, was a wood-engraver before he became a painter. There were many others.

But another beautiful handicraft that fell to be adversely influenced, as the new method became perfected and more widely adopted, was that of chromo-lithography, and soon a large proportion of the work left to be produced in these islands began to be printed by three and four colours by the letterpress method.

And this was not a consummation devoutly to be desired. True, for much of the best lithography British consumers were going to Germany, notwithstanding that that country has never turned out by the art-craft of chromo-lithography work more excellent than that produced by, to go no further, Messrs. Griggs, of Peckham, and Messrs. Vincent Brooks, Day & Son, who have a proud record, and Messrs. M'Lagan & Cumming, of Edinburgh. If I mention these names it is by reason of the high character of their work over a long period, and the possession of an indomitable resolution which has enabled them to put up a good fight against a competitor so well equipped and privileged. The chromo-lithographer still has a field of work which the three-colour printer can never occupy so successfully; and it is well the colour printer should recognise this. Some of the greatest failures of the letterpress colour printer have been made by attempting work which is better left to the older method of printing.

Although the newer method has had a disturbing influence on the—if I may so term them—more human crafts I have referred to because of its mechanical foundation, the processes of engraving and printing demand in both departments unceasing watchfulness and care, as well as the highest application of skill and knowledge. The human element is essential in the last degree. The workers need to be always at concert pitch, their vigilance must be unceasing. Relaxation means with certainty a spoilt negative or plate; in the printing machine-room, deterioration of result.

Each original picture or object will be found to differ from its fellow, and call for more or less individual treatment in the studio and etching-room. In like manner the printer usually also finds plenty of play for his mentality, so that if the method has displaced one set of human activities it has brought others into play.

May I, speaking as a printer, make another reference to the colour-engraver's task? I need not here dilate on the necessity for harmonious working in each department; it is somewhat repugnant to the British spirit to be asked to consider another man's job and difficulties. The engraving staff must work together like a well-trained football team, each ready to play into the hands of the other.

Careful lighting of the object, the correct exposure, equally careful printing on the copper, and nice judgment in the etching of the plate, to say nothing of the proofer's work, are all demanded. When all receive their due attention there is little work left for the fine-etcher—who should be, as far as possible, the unobtrusive human element in a scientific process.

One of the greatest failures recorded in the history of colour printing in this country resulted from half a dozen men going their own way instead of considering the possibilities and limitations of the other departments. They all wanted to row stroke oar, and the boat scarcely got off the mark.

Many years ago I took a proof from a roughly-etched set of colour plates to the studio of a well-known R.A.—he is at the moment president

of a Royal Society—in order that notes might be taken before the fine-etcher commenced his work. The picture had been photographed at the artist's residence. To my surprise he suggested that it might be printed as it then appeared. It gave his drawing. He overlooked unfaithfulness to colour rendering of the original, because there was an utter absence of the retoucher's handiwork.

In the case of pictures of merit, especially, the greatest care should be observed—although the rule applies generally—not to over-etch a plate. I think over-etching is the most fruitful cause of trouble in true colour reproduction. It springs largely from the Britisher's readiness to take a risk. The most skilled engraver or burnisher, working on a multitude of dots of varying strength, can never give back that which he has allowed the bath, by imperfect judgment, to eliminate.

As one who has suffered long and much from the result of over-etching, I should say that more money has been wasted in the endeavour to patch-up —it is nothing else—plates so treated, with its additional waste of time and money in reproofing, than would have paid for the remaking of the plates twice over.

I have referred somewhat at length, if lightly and generally, to the engraving side of colour printing, in order not only that I may call attention to their difficulties, but also pay my tribute to the excellent work of a large body of craftsmen who are often called upon to work miracles in the matter of time, and to achieve the impossible by reproducing work which might have been painted by someone who had a big grudge against the method. Especially I wish to counteract the notion possessed by many people that the photo-engraver simply presses a button and rocks an etching-bath. The printer whose work it is to collaborate with the engraver should form a just estimate of the demands on his colleague's judgment and skill.

I have spoken of the dependence of the colour printer on the ink manufacturer, and given expression to the hope that colour chemists of eminence may, in the near future, be persuaded to devote some of their scientific knowledge and abilities to the industry. I may also here point out that the printer's reliance on the paper manufacturer is almost absolute. The printer daily brings his experience to bear on the treatment of his coloured inks, but a badly-made paper will defy all the resources of his skill and experience. A paper may be kept in a machine-room of even suitable temperature for two or three weeks, and still give endless trouble, unless the "body" of the paper was well matured before receiving its coating, and due time was allowed to elapse before finishing. I remember an instance of a printed sheet, 36 in. wide, showing, after momentary exposure to the atmosphere, a variation of nearly one-eighth of an inch on being immediately run through the machine again.

It is to be regretted that a substitute for coated paper has not been found, which shall give equal printed results from the half-tone colour blocks with the same ease and certitude. The best effect of the half-tone, with all its variations of light and shade, are—as in the early days of the process—got on the sympathetic art paper, and the indefinite or "fuzzy" appearance when printed on most calendered papers is accentuated when the impressions of three half-tones are superimposed.

Much really excellent colour printing, generally in four printings, is produced in the United States of America on non-coated papers of highly finished character. The fourth printing is essential to good result on such material. These papers have not "caught on" with home printers. They have the advantage, however, of less susceptibility to atmospheric conditions. Excepting in the more expensive kinds—wood being the principal ingredient—the colour soon deteriorates, so that they are unsuitable, as are clay-coated papers, for work intended to be of enduring usefulness. Unless the qualities of sharpness and beauty of impression are to be in considerable degree sacrificed, I fear the following criticism, directed against colour printing on coated papers, will long be pertinent: "It is now well understood that many of the beautiful and luxurious editions and periodicals published within the last few years, at an immense expenditure of time and work, will last but a short time. And it is most especially unfortunate that artistic inspiration, which has expressed itself in the illustration and composition and printing of such works, will not become a heritage of future generations."

"'Tis true, 'tis pity;
And pity 'tis, 'tis true."

British paper manufacturers have made gallant attempts to meet the objection just referred to. My own printing trials, at the request of papermakers, have been legion. Twelve or thirteen years ago Messrs. Joynson, the well-known writing-paper manufacturers of St. Mary Cray, and Messrs. John Dickinson & Co., at one of their Hertfordshire mills, were both

working assiduously, I believe unknown to each other, in the endeavour to produce a rag printing-paper, and so of great permanence, which could be used for the best class of three-colour illustration. The former firm, after exhaustive experiments and much cost, I believe, gave up further endeavour. Perhaps those present will be most interested if I refer specifically to my experience in printing an important series of illustrations on paper manufactured by the latter firm—Messrs. Dickinson—which they termed their "Rag impression." The late Mr. Thomas Barratt (of Messrs. A. & F. Pears, Ltd.), who supervised the preparation of his " Annals of Hampstead " for the press, determined that the whole of the paper to be used, both for the letterpress and illustrations, should be, as far as humanly possible, non-perishable. To this end he decided to use rag-impression paper.

The finished results obtained on this medium were, in many cases, entirely satisfactory; but, unfortunately, owing to the difficulty of securing regularity of evenness of finish—absolutely essential in a method dependent on " contact " of paper and block in contradistinction to " squeeze "—a considerable amount of waste occurred in printing the heavier subjects. It is greatly to be regretted that the manufacturers subsequently abandoned the production of this permanent substitute for the perishable coated material. I have, in addition to a number of smaller works, printed a series of quite large four-colour blocks on the rag paper for one of our largest advertisers, who, having spent considerable sums of money on original paintings, decided that the reproductions should be made on a permanent material. I show two sheets of plates for Mr. Barratt's book, all printed from four-colour blocks on rag-impression paper.

" The Bird's Nest " is shown printed on the same material and on coated paper in order to allow of comparison of results. The comparatively light and delicate nature of this subject renders it more suitable both for the three-colour process as opposed to four colours and for printing on non-coated paper, although it will be noticed that even this little subject loses in sharpness when printed on the latter.

At least four printings are required to get anything like successful results on such paper, especially if the subjects are strong and the blocks carry depth of colour.

I was about making further experiments in printing on paper of this kind, when unfortunately Messrs. Dickinson, owing to the difficulty of manufacture, dismantled the special machinery they had built and stopped further supplies.

I have stated that a leading principle of colour printing by the three- and four-colour process is contact instead of pressure. Another is the efficient cleaning of the plates after each impression, *i.e.* the blocks should deposit practically the whole of the colour on the paper at each impression. If the strength of impression is extreme the picture will be dulled by the spreading of the colour, which will also be forced into the extremely minute interstices separating the screen " dots." This, which makes not only for " fuzzy " but also dirty work, is an insuperable bar to the general use of the otherwise very desirable uncoated papers. Their necessarily imperfect surface demands heavy pressure for the purpose of receiving an equal distribution of colour on even and uneven parts.

I have referred to the sympathetic co-operation necessary in all departments of the photo-engraving house. The sympathetic co-operation of engraver and printer is a *sine qua non* in successful colour reproduction by mechanical processes. It is but fair to say here that, but for it, we could not have produced the large gallery pictures which I am permitted to exhibit in illustration, and I am happy to give expression publicly to grateful thanks for such co-operation and help. When a series of plates is imposed in one large forme—for the size of sheet that can be printed from three- or four-colour blocks is regulated only by the dimensions of the printing machine and the skill of the machine printer—the printer requires blocks which have been proofed by the engraver not only in the same shades of the primary colours, but also with the same strength of colour and the same amount all over the surface of the plate. At the moment we are printing for a photo-engraving firm a sheet containing fifteen or sixteen quite large blocks. Half a dozen of these had been proofed each with a different colour of blue ink—a very serious handicap to good printing. Quite recently we discovered that a large plate when proofed carried on the left-hand portion almost double the amount of colour used on the other. As we were called upon to print in duplicate, and therefore to roll in the reverse way to that in which the block had been proved, our task was not lightened. Some system of standardisation on the part of engravers might produce better results.

Hitherto I have confined myself to consideration of the ordinary method of printing the various colours separately, but machines have been invented for the simultaneous superimposition of colour, and although no great progress has been made by these in England, they at least deserve mention. Some few houses employ coupled-up presses which carry the sheet in one journey through its three impressions. In the opinion of many competent judges this method finds its best scope on long runs for which the highest class of result is not demanded. I have never found that the continuous run and the practically simultaneous printing of colours one over the other gives sufficient sharpness and beauty of result, and I have not been tempted to adopt this time-saving device. The method used by the Quadri-Colour Co., a United States house, produces much excellent work, but a strong family likeness pervades all its productions.

In production for commercial purposes speed is often vital, and here the three-colour process possesses obvious advantages. As one instance in point, I may be allowed to cite a personal experience. When the news of the death of Commander Scott, of the Antarctic Expedition, reached England, I was commissioned by the management of one of the London illustrated weekly newspapers to reproduce a coloured photograph of the hero's little son, Peter. The coloured photograph was received by me shortly after noon on Friday, and by the following Wednesday the large edition demanded was delivered, printed in three colours and plate-marked. What colour process can compete with this in celerity of production ?

A process capable of meeting so insistent a demand, as well as those more leisured—though it is to be feared that few leisured demands come the way of the printer—of discriminating art lovers, dealers and publishers, must of necessity be a powerful instrument in the hands of commercial men. To enumerate would be but to repeat the story of the all-embracing usefulness of this interesting means.

There is indeed no royal road to colour printing by this process. Every job brings its own little difficulty, and therein lies the charm of the process for the craftsman. In general terms I am an enthusiastic advocate of the standardisation of industries. Yet I hope that I may not live into an age when blocks, ink, paper, machines and men have been conformed to such an extent as to relieve the calling of its human element. Our very deficiencies and imperfections are among our best incentives to progress. A complicated and difficult subject calls forth the utmost efforts of studio and etching-room, and these are reinforced by vigilance and sympathetic treatment on the part of the printer. When the personal equation is rightly adjusted, material and mechanical obstacles which might otherwise appear insurmountable may often be overcome, or at the least rendered much less formidable, and the worker braced and better equipped to grapple with the next problem.

The Renaissance Method.

I now pass to my connection with the "Renaissance" machine, manufactured by Messrs. Linotype & Machinery, Ltd., to whom colour printers by relief and other methods are much indebted.

In illustration of the story I have the pleasure of submitting for the inspection of the audience several specimens of work done on the machine, all of which, with the exception of one printed at the Broadheath works of the company, were produced in my office in London.

The Renaissance method differs from ordinary intaglio photogravure in the respect that, instead of the subject being engraved direct on a copper cylinder, which, after being placed in position on the machine, has the surplus ink removed from it by a steel knife before coming in contact with the paper, the subject for printing by this process is etched on a flat sheet of copper, such as is used for an ordinary half-tone engraving. The "Renaissance" is a sheet-feed machine possessing two reciprocating cylinders, grooved to hold, by clamping, steel turtles on one of which is fastened the engraved copper plate, and on the other a sheet of rubber which receives the impression from it. This, in its turn, is transferred to paper, which, passing round a smaller cylinder, is pressed with due force to receive it.

The inking apparatus consists of a duct admirably controlled as to supply of ink, and three distributing and three inking rollers. After the plate has been inked, it travels to the wiping rollers, which are placed beneath the cylinder. It is there cleaned of all the ink not required before coming in contact with the rubber.

Thus, by an ingenious combination of intaglio (or photogravure) and offset methods, a print is obtained which embodies the outstanding properties of both processes. The photographic screen is very much less palpably in evidence than in direct intaglio photogravure, owing to

the almost imperceptible spreading of the colour when deposited on the paper.

Before going farther, it may be noted that one great advantage enjoyed by the "Renaissance" over ordinary photogravure is the fact that the Renaissance plates holding the engraving may be stored for future editions in the same way as ordinary half-tones, stereo and electro plates; while the intaglio method, pure and simple, implies, for the purpose of fresh editions, storage of the etched cylinders, which is quite impracticable, or the regrinding of the cylinder, a fresh deposit of copper and a re-etching. It was the practicability of retaining plates for future use that, among the advantages which the machine seemed to possess, appealed to me, as a practical printer, very strongly.

Let me make the interpolation that, with the exception of a very small job, all the specimens shown in illustration of the Renaissance method must be considered as first attempts, as purely experimental work.

To demonstrate then the commercial, and so the practical, character of the machine, I had a small medallion portrait of Dr. Johnson—from a stipple engraving by Bartolozzi—etched and printed for a cover for an 8vo booklet. Two or three months afterwards, a second edition being called for, the original plate was placed on the machine and printed as previously, an operation calling for only two or three hours' labour.

A very short experience with the machine satisfied me as to the exactness of register and complete control of ink supply. Being assured on these points, and also that the process afforded a sure means of printing by photo-engraved plates on uncoated paper, I determined at the outset to test it for colour printing. To save time, and as a ready means of demonstration, I procured a set of reversed half-tone three-colour blocks, which afforded some sort of cell for the reception of the colour to be deposited on the rubber. This test was carried out with the roughest of etching, the ordinary three-colour primary inks, and a miscellaneous assortment of paper. The result fully satisfied my expectations. A few hours sufficed to clean up the machine, get the plates in position, run up the colour, and take a few impressions. Until we got the second plate in position and an impression in its colour on the yellow ink, I really believe some of the experimenters thought they perceived the dawn of second childhood. It did not take long, however, to discover method in the madness.

The first plate printed in colour I have the pleasure of showing you.

The first experiments in colour gave no advantage, but the contrary, to coated paper, as might have been expected; but the results on some cheap interleaving paper I had provided for the purpose were as good, or nearly as good, as those on etching and similar papers of varying degrees of finish.

The machine was subsequently installed in my premises in Gough Square, where the reproduction of a water-colour drawing of the "Two Turks"—the first picture in colours engraved by the intaglio method and printed on the "Renaissance" machine—was produced; as were the other specimens which I have the pleasure of showing to-day, along with the progressive working proofs and the plates from which they were printed. I had plates of moderately large size made, as it was essential that proof should be given as to the possibility or otherwise of securing register with intaglio plates of considerable size. Afterwards plates were made for the Thorburn "Pheasant" print, in four printings. Two plates mentioned, and the plate containing the four Indian subjects (which I had etched together to demonstrate the feasibility of obtaining register when more subjects than one were desired on a plate), are so far the only plates produced in colour by this method.

Much of the beautiful chromo-lithographic work produced in London forty and more years ago owed its excellence to the fact that painters of eminence did not consider it derogatory to their dignity to work on the lithographic stone when their own pictures were the subject-matter, and often did much more than put the finishing touches to them. The artist cannot object to the material that can be used by this method for printing reproductions of his work, for the only difference with a coarse-grained paper is that of increased softness of result, due to slightly more spread of the colour when deposited by the rubber. With the working of the "Renaissance" method his individuality would be conserved by study of the simple method, and taking pattern by the work of painters of a past generation, the three or four positives would offer him every opportunity for a like assistance.

It may be accepted as an established fact that almost any make or grade of papers may be used for indirect intaglio printing. Bristol boards, etching papers of varying degrees of roughness, Whatman and other hand-mades are

specially suitable, whilst the poorest results are obtained by the use of the heavily-coated papers found almost indispensable in ordinary three-colour and half-tone printing, and super-calendered papers.

It should be borne in mind when considering the results of a few months' experimental work that none of it is considered at all perfect, that the plates were made nearly three years ago, that the engravers were busily occupied in perfecting their methods for direct intaglio printing from the cylinder at the time they gave me their help, and that the two methods call for different treatment in etching. I am glad to be able publicly to express my thanks for valuable assistance from Mr. E. H. Rudd and from the staff at Messrs. Lascelles, who etched the intaglio plates for me at considerable inconvenience to themselves, and to Messrs. Winstone and Messrs. Shuck and McLean, who also gave me most cheerful and valued help with inks and colours.

The two impressions in red, from stipple engravings, were made from very imperfect originals.

Much of the fine work which was apparent in the reproduction from a pencil drawing of the Italian view, when first put on the machine, has been lost by reason of taking a number of impressions without protecting the very delicate work by steel facing.

The large plate of Dr. Johnson examining the MS. of "The Vicar of Wakefield" is from a mezzotint engraving, and is printed on common interleaving paper.

Letterpress matter reproduces perfectly, and I would point, in proof of this, to the very minute lettering of the engraver's name under the small medallion of Dr. Johnson on the cover referred to previously.

I have made reference thus far to results obtained and advantages of the machine. I have avoided reference to difficulties, not because there are none, nor because they have not yet all been surmounted, but because in them I am unable to perceive natural difficulty.

As a printer still possessing a lively recollection of all the travail and loss and disappointment experienced in the first years of working the three-colour method, and still finding a plentiful crop of difficulty springing up in working the process, I think that as the result of first experiment the large plates in colour printed on the "Renaissance" machine are at least interesting.

Just previously to war breaking out I was visited by the gentleman controlling the largest photo-engraving establishment in the United States of America devoted to intaglio work, four-colour—he said they never made three-colour—and half-tone and line. He was more than interested. He remarked that it was, in his opinion, the solution of printing photo-engraved plates on other than coated papers, and that, had he the machine in one of his establishments, he would create a department for producing only colour plates for the machines, and that he would not allow one to go out as a finished product until the staff were able to produce perfect printing plates with the same certainty as they now enjoy in producing for the method in general use. If I have been unduly optimistic about the "Renaissance" machine I have erred in excellent company.

With the outbreak of war my experimental work came to an end. The engineers who designed the machine found a more pressing demand for their activities. The future of Renaissance printing, therefore, is in the lap of the gods.

DISCUSSION.

The Chairman (Mr. Carmichael Thomas), in opening the discussion, said he was sure all present had been very much interested in the paper that had just been read. Personally he had been especially interested in what the author had said about the three-colour *versus* the four-colour process. In that respect he thought a great deal depended upon the subject of the picture. For instance, a richly coloured Old Master could not be satisfactorily reproduced by the three-colour process; it seemed to need a neutral or black tone, preferably the former. Certain subjects, however, specimens of which he exhibited to the meeting, were quite capable of being reproduced by the three-colour process. The success of that process depended a great deal upon the proofer; if the proofer would only have the original in front of him and ask himself what shades of colour were in that picture and then try to reproduce them accurately, a satisfactory result could be obtained, and one that would be much more economical to the process-engraver. With regard to the author's remark that "the conductors of the best illustrated newspapers had moderated their enthusiasm since the outbreak of war," that was a case of necessity. Their workmen had been taken away from them, sufficient quantities of paper could not be obtained, and also a great deal of the ink required formerly came from Germany, and was not obtainable at all at the present time. Such progress, however, had been made in the direction of producing the ink in this country, that he hoped after the war we should no longer have to depend upon Germany for ink. The

author mentioned that the recent issues of the principal illustrated weekly newspapers published in Germany showed no diminution in the amount of colour work they contained, and in that connection he had brought with him several copies of the *Illustrirte Zeitung*, which he exhibited to the meeting. He would like to point out that the German Government looked upon newspapers as very useful for propaganda work, and therefore gave them a good deal of assistance. Some of the most beautiful effects in colour printing had been produced by the aquatint method, which had really been superseded by three-colour work. The author's account of the "Renaissance" method was very interesting, and there was, no doubt, a very great future in front of it. He was glad to hear the author say that efforts were being made to find something better than the coated paper that was now so commonly used. An important committee appointed by the Society of Arts in 1897 had shown, by making inquiries and collecting evidence on the subject, that it was quite impossible to preserve coated paper for more than a few years. He remembered that one of the officials of the British Museum said that some of the expensive books in the Museum, printed on coated papers, had had to be cut to pieces and each page bound separately with a piece of tape.

Mr. R. A. Peddie said he had listened to the paper with great interest, especially that part of it dealing with the "Renaissance" machine. He had always had a great dislike for coated paper, and in certain papers he had written he had said some very unpleasant things about it. No doubt it had been a necessary evil, but he hoped that either the "Renaissance" process or some other process would come to the front and obviate the necessity for the use of coated paper. As the author had proved by the prints he had exhibited to the meeting, it was not absolutely necessary to use coated paper for three-colour or four-colour work, but presumably the whole question was one of cost. Books had been produced containing no coated paper at all, but they were very expensive—much too expensive for the general public to purchase. He was not speaking as a practical printer, but he thought the author would bear him out when he said that it was rather a question of spoilt sheets when non-coated paper was being used, because the surface was certainly not so fine as that of coated paper. He thought it was a little doubtful whether the non-coated paper would last much longer than coated paper, because he was under the impression that it had to be beaten very much more than ordinary paper, and—the length of the fibre being reduced very considerably—the tensile strength of the paper was consequently less. He had examined a great many aquatint reproductions, and had very rarely been able to find one printed entirely in colours; generally one or two colours, or at any rate one or two tints, had been added by hand.

Mr. Adam Black said that in certain instances coated paper had not begun to disintegrate after twenty-five years.

Mr. C. Abbott Pasquier said that the work reproduced by the *Graphic* prior to the introduction of the three-colour process was all done by the aquatint method, there being a great advantage in the depth of the plates and the long run made on the machines by that process, and very accurate facsimiles of the originals were obtained.

Mr. A. S. Jennings asked the author whether it was possible by either the three-colour or four-colour process to reproduce accurately the solar spectrum.

Sir Henry Trueman Wood, being asked by the Chairman if he could reply to Mr. Jennings' question, said he had seen a great many attempts to reproduce the solar spectrum, but had never seen anything which came near the original. He did not think it could be reproduced by the three-colour process. The only satisfactory reproduction of the spectrum he had ever seen was one by Professor Lippmann. It was very small and was not capable of being multiplied.

Mr. G. W. Jones, in reply, said that with reference to his remark that Germany was continuing to use colours for the embellishment of its weekly newspapers, he had recently been given to understand that the printing works that carried out the better-class work were not being used at present. He could quite believe that, because this country had been the happy hunting-ground of Germany in regard to colour printing, and naturally they would want to keep their plant as intact as possible, in order to regain their old markets as soon as possible after the war. With regard to rag paper, he quite appreciated its merits, and thought that the pictures in Mr. Barratt's book "Annals of Hampstead" looked very much finer on rag paper than they would have done on coated; but, on the other hand, coated paper often gave a clearer and sharper effect. He agreed with Mr. Peddie that the difficulty of printing on rag paper was that the surface of the paper was not so mathematically even. As he had pointed out in the paper, good colour work could not be obtained by "squeezing" it must be done by just sufficient "contact" of the paper and block. The cost of rag paper was very much greater than that of other paper. He was very sorry that, as he had stated in the paper, Messrs. Dickinson, owing to the difficulty of manufacture, had dismantled the special machinery they had erected at great cost for the manufacture of rag paper.

On the motion of the Chairman, a hearty vote of thanks was accorded to Mr. Jones for his interesting paper, and the meeting terminated.

ARTS AND CRAFTS.

The British Industries Fair.—This year, instead of dividing up so many of the exhibition halls at the Victoria and Albert Museum, the Board of Trade very wisely decided to house the toy section of the British Industries Fair in the Imperial Institute. The result of this plan was very satisfactory. Not only were lovers of the museum spared the shock which last year's erections inevitably gave them, but it must be admitted that the exhibition at the Victoria and Albert Museum gained in dignity and seriousness from the banishment of the toys, and from the fact that the buyer interested in, say, the printing trades or in pottery and glass did not have to make his way to his business through an avenue of teddy bears and other "soft toys." The new arrangement may have been due to difficulties of labour and construction, but it certainly made for the greater effectiveness of the exhibition as a whole. We in England have not the inborn faculty for arranging exhibitions, which is so marked a characteristic of our French Allies, but it is to be hoped that we are on our way towards acquiring some measure of competence in this respect. The toys last year were many of them excellent—there is, perhaps, no industry upon which the war has had so vitalizing an effect—but they were not the most fitting introduction to the exhibition.

Toys.—The soft toys this year did not make such an imposing show as they did in 1916, but the catalogue proves that they were exhibited by an even larger number of firms. Some of them had a real claim to artistic merit, but there is a tendency in certain quarters (especially, apparently, amongst the country and the semi-philanthropic makers) to produce a weird and rather unpleasing type of soft doll or animal which is rather striking in its effort after originality than genuinely attractive. Metal toys were naturally not peculiarly numerous, but there was an abundance of British-made soldiers, and their quality, artistically at least, showed a distinct advance, whilst in some cases their arrangement was not only ingenious, but gave evidence of real taste. The wooden toys, again, displayed a steady movement in the right direction, and many of the dolls'-houses, farms, shops, etc., displayed a real regard for artistic effect. This really seems the direction in which there has been most progress in the last three years. The building bricks planned to construct houses designed by a real live architect also showed a striving after beauty which was quite absent from the pattern sheets supplied with the building blocks of an earlier generation.

The Printing and Fancy Trades.—In the printing trades section there was, perhaps, nothing so arresting as one or two of last year's exhibits. The same firms show in the main, it is true, but they cannot issue striking novelties every year, especially in war time. The most interesting wares in this section were, perhaps, the children's books, many of which were charmingly designed and, though printed in the bright pure colours so dear to the heart of the child, they escaped any suspicion of crudeness in colouring. Messrs. George Harrap showed some very good children's books, and Messrs. Blackie and Son's exhibit, especially the set of drawings by Florence Harrison, was of very real interest. Messrs. A. M. Davis and Co. showed some admirable postcards, amongst which the flower cards of H. G. C. Marsh Lambert were deserving of special mention. They recall inevitably the work of Walter Crane and of Ottilia Adelborg—one can hardly imagine that they would have been produced had neither of these artists paved the way—but they are none the less charming. Messrs. Raphael Tuck's show included some rather amusing cards in bright colours with some affinities with cubism. The Medici Society's cards are in a class apart, and represent the highest point to which British makers have, so far, attained. Messrs. Dean and Son's stencil books, which contain plates ready cut, ought to be of considerable help in schools where it is recognised that, though there is no time to teach the children how to cut their own stencil plates, there is yet much which they can learn, in the way both of manual dexterity and of that arrangement which lies at the root of design, by stencilling units on a variety of plans. Fancy articles are not generally of any great artistic value, and the exhibits at the Fair formed no exception to the rule. It is interesting, however, to note that some firms are producing leather goods of the type with which German makers used in pre-war days to flood the Italian market with considerable success. Messrs. Henry Wolff and Co.'s lamp shades, especially those in orange silk decorated with really good patterns in black pigment of some kind which stopped out the light where it was applied and produced a most happy effect, were well worth notice. Mr. A. J. Rowley, whose "Artrec" work is now very well known, showed some experiments in lacquer on wood which promise well for the future.

Pottery and Glass.—The exhibits in the pottery and glass section were interesting on a rather different level from those of last year. Very few tiles were to be seen, and several of the firms best known for the production of artistic work of real technical excellence were unrepresented, whilst there was a larger amount than last year of more or less artistic work of the peasant type. Amongst this last the primitive-looking unglazed pottery shown by Messrs. Carter of Poole, which might have been imported from Mexico or dug up from some ancient tumulus, was by far the most attractive. It struck one as being rather brittle, but in its rude archaic way it was extra-

ordinarily satisfactory. There was a good show of Baron's Barnstaple ware, and the Ravenscourt Pottery sent some up-to-date work decorated fairly successfully with chequer patterns. Amongst work of more technical achievement the Upchurch salt glaze ware was distinguished by a certain dignity of form as well as by its rather cold and restrained colour. There was an interesting exhibit of Moorcroft ware which included some good lustre effects in blue and purple. The yellow lustre ware was not quite so successful in colour. Messrs. Shorter and Son showed some matt glazed vases with fine broken effects of colour, and there were some good examples, some of them rather overgilded, of Wedgwood china lustre ware. Messrs. Birks, Rawlins and Co. showed some *pâte sur pâte*, which, though not by any means so delicate as M. Solon's work used to be, was a good deal better than the average. The glass trade was well represented. Messrs. Webb of Stourbridge sent an interesting collection of glass, and the stand of Messrs. Stevens and Williams of Brierly Hill included, amongst other work, some very successful rose bowls. Mr. and Mrs. Reginald Hallward's stall showed how much can be done to enhance the attractions of the exhibits by a tasteful arrangement of the space at the exhibitor's disposal.

GENERAL NOTES.

HENNA.—Henna, which has been used from the most remote times as a dye plant, is the subject of a monograph by F. Cortesi and G. Tommasi published in *Annali della R. Stazione Chimico-Agraria Sperimentale di Roma.* The Arabs employ it as a cosmetic for different purposes, and also as a medicinal plant. Its dyeing qualities are widely utilised for wool, silk, and wood. The plant is extensively cultivated in the fields of Tripoli, always under irrigation. The plantlets are raised in nurseries, and transplanted in the spring, in parallel rows at a distance of 50 by 50 centimetres. No manure is applied, but irrigation is carried out every six days. The plants are cropped for about twelve years, the maximum growth being reached in the second or third year. The crop is usually taken off in February, and again in August or September, the whole of the above-ground portion of the plant being cut. The annual yield of dried leaves varies from 15 to 19 cwt. per acre.

THE PAPER INDUSTRY IN THE U.S.A.—The latest census of manufacturers in the United States shows that in America the manufacture of paper is second in importance only to the steel industry. The total invested capital is estimated at $500,000,000, while the annual value of the manufactured product of the paper and pulp amounts to $350,000,000.

CHINA COTTON-SPINNING AND WEAVING INDUSTRY.—According to a report by the Canadian Trade Commissioner at Shanghai, the development of the cotton-spinning and weaving industry in China is worthy of careful study. Scarcely more than thirty years ago not a single cotton-spinning or weaving mill fitted with an up-to-date plant and operating on modern lines could be found in China. By careful inquiries it has been ascertained that thirty-seven such mills have been established since then. Now that a start has been made, a more rapid and extensive development in this branch of industry in the future may confidently be expected. Of the thirty-seven cotton mills, twenty-one are situated in Shanghai, while the rest are scattered throughout the four provinces of Kiangsu, Chekiang, Hupeh, and Honan. Most of the larger and more flourishing mills at Shanghai have been established and are working under foreign direction. There are five Japanese seven British, and nine Chinese mills in Shanghai, the latter including two in the course of being established. One of the British mills, having 72,264 spindles and 580 weaving machines, is the largest, and the Nisshin mill (Japanese), operating 10,000 spindles, is the smallest. The total number of spindles in the twenty-one mills at Shanghai is estimated to be 642,984, and the number of weaving machines to be 3,204, including those of the two Chinese mills not yet working.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. :—

APRIL 18. — HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance."

APRIL 25.—SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

MAY 2.—J. C. SHENSTONE, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future."

MAY 9.—PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

MAY 16.—SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

INDIAN SECTION.

At 5 p.m. :—

TUESDAY, MARCH 27. — SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., M.D., F.R.C.S.,

President, Scientific Advisory Board, Indian Research Fund Association, "Opportunities for Original Research in Medicine in India." The RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, will preside.

At 4.30 p.m. :—

THURSDAY, APRIL 19.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

Date to be announced later :—

D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

HOWARD LECTURES.

Monday afternoons, at 4 p.m. :—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market. April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 26...Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Mr. J. Falconer, "The Ploughing up of Grass Land and its Subsequent Treatment."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Miss M. Ashworth, "The Education of Women in India."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m. Professor H. S. Foxwell, "Inflation: In what sense it exists; how far it can be controlled."

TUESDAY, MARCH 27...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. (Indian Section.) Sir Havelock Charles will read a paper by Surgeon-General Sir C. Pardey Lukis, "Opportunities for Original Research in Medicine in India."

Sociological Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Professor L. W. Lyde, "Europe *v.* Middle Europe."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. W. Gregory, "Geological War Problems." (Lecture III.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. H. Allcock, "The Decimal System of Coinage, Weights and Measures."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. R. P. Howgrave-Graham, "Chaucer's Pilgrim's Way—From the Tabard Inn to Canterbury *via* Sittingbourne."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Miss M. E. Durham, "South Slav Customs and Beliefs as illustrated in Old Ballads and in Tales by Serb Authors."

Colonial Institute, Caxton Hall, Westminster, S.W., 4 p.m. Mr. J. Baker, "The Kingdom of Bohemia: a Buffer State against Berlin."

WEDNESDAY, MARCH 28...Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS John-street, Adelphi, W.C., 11 a.m. (Annual Congress.) 1. Chairman's Address. 2. Mr. D. B. Morison, "Standardisation as Applied to the Machinery for Cargo Boats." 3. Mr. W. J. Lovett, "On a Method of Obtaining for Ship Design the Spacing of Bulkheads according to the Rules of the International Convention."

3 p.m. 1. Mr. J. Montgomerie, "Stress Determination in a Flat Plate." 2. Signor E. Benvenuti, "The Closing of all Ship Side Apertures from the Bridge." 3. Mr. T. Graham, "Description of an Apparatus for Interpreting Stability for the use of Shipmasters."

7.30 p.m. 1. Professor W. E. Dalby, "The Strength and Inner Structure of Mild Steel." 2. Lieutenant W. A. Scoble, "Design of Pin Joints based on Ultimate Strength."

Japan Society, 20, Hanover-square, W., 5 p.m. Dr. Haga, "The Spirit of Japan (Yamato Damashii)."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Right Rev. Bishop Boyd-Carpenter, "Dante and Boethius."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Lieut.-Colonel Sir Alfred P. Gould, "Personal Habits in relation to Public Health in Time of War."

Geological Society, Burlington House, Piccadilly, W., 5.30 p.m. Mr. F. Dixey, "The Carboniferous Limestone on the South-Eastern Margin of the South Wales Coalfield."

THURSDAY, MARCH 29...Naval Architects, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. 1. Mr. W. J. Luke, "Further Experiments upon Wake and Thrust Deduction Problems." 2. Mr. J. J. King-Salter, "Some Experiments on the Influence of Running Balance of Propellers on the Vibration of Ships." 3. Sir George Greenhill, "Theory of Wave Motion on Water."

3 p.m. 1. Mr. J. H. Macalpine, "Marine Application of Reduction Gears of Floating Frame Type." 2. Messrs. P. A. Hillhouse and W. H. Riddlesworth, "On Launching." 3. Professor W. Hovgaard, "Buoyancy and Stability of Submarines."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. Mr. W. Bateson, "Professor T. H. Morgan's Work on the Mechanism of Heredity."

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Miss E. F. Smythe and Principal S. Hicks, "Vocational Guidance and the Trade School."

Royal Institution, Albemarle-street, W., 3 p.m. Professor J. A. Fleming, "Modern Improvements in Telegraphy and Telephony." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. A. A. Campbell Swinton, "Forty Years of Progress."

China Society, Caxton Hall, Westminster, S.W., 3.30 p.m. Dr. L. Giles, "Ch'iu Chin: a Chinese Heroine."

FRIDAY, MARCH 30...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor J. H. Jeans, "Recent Developments of Molecular Physics."

SATURDAY, MARCH 31...Royal Institution, Albemarle-street, W., 3 p.m. Mr. S. Graham, "Russian Idealism: the Ideas of the Russian Philosopher, Vladimir Solovyof." (Lecture II.)

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FRIDAY, MARCH 30, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

DEATH OF H.R.H. THE DUCHESS OF CONNAUGHT.

At their meeting on the 26th inst. the Council passed the following resolution :—

"The Council of the Royal Society of Arts desire to offer to the President of the Society, His Royal Highness the Duke of Connaught, their humble condolence on the occasion of the death of His beloved and popular Consort, and to tender to His Royal Highness an expression of their dutiful and loyal sympathy with Him in His bereavement."

INDIAN SECTION.

Tuesday afternoon, March 27th, 5 p.m.; THE RIGHT HON. AUSTEN CHAMBERLAIN, M.P., Secretary of State for India, in the chair. A paper on "Opportunities for Original Research in Medicine in India," by SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., M.D., F.R.C.S., President, Scientific Advisory Board, Indian Research Fund Association, was read by Surgeon-General Sir R. Havelock Charles, G.C.V.O., M.D., F.R.C.S.I., President, Medical Board, India Office.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, February 27th, 1917; Mr. W. A. S. HEWINS, M.P., in the chair.

The paper read was—

THE EMPIRE'S ASSETS AND HOW TO USE THEM.

By ALFRED BIGLAND, M.P.

Before entering upon the detailed consideration of my subject I should like to place before you, by way of preparation, one or two brief illustrations designed to indicate certain axiomatic truths which serve as a starting ground for my subsequent remarks.

A near relative of mine, who is an artist, painted a very large picture which many of us so admired that we begged him to have it reproduced in colours on a small scale. Accordingly, he commissioned a competent firm to do the work, and the reproductions were faithfully made; but, to everybody's great disappointment, there was something wrong, yet it was difficult to tell what. The details were reproduced accurately, and the colourings were the same; yet the effect was quite different. The trouble was simply this, that the reproduction was too faithful. The same colours, which in the original blended harmoniously, in the reproduction were crude. In other words, the process of reproduction failed to take account of the different scale.

To take another illustration. A poor city clerk is suddenly faced with some liability far in excess of his annual income. What does he do? Having no capital he has to raise the necessary money and repay it, maybe, at high interest, to some usurer over many years; in fact, his whole life may be blighted by the burden thrown upon him. But a company confronted with a similar liability acts very differently. It may have to realise certain assets, but more probably increases its capital and launches out in fresh activities, in order to make up in one direction for what has been lost in another. A huge combine thinks nothing of a financial blow that would stagger a firm organised on ordinary lines, but sets to work to extend its operations—probably emerging ultimately from the struggle with an adverse situation even stronger than before, with its interests more widespread and its prosperity on a broader foundation. The larger the body the more easily can it overcome financial difficulties, even though these difficulties may be greater in proportion than those sufficient to afflict and overwhelm smaller concerns. But the point to be remembered is that the large body succeeds by reason of its larger resources, which enable it to employ methods inapplicable to the small concerns.

I wish to put before you to-day the position in which this Empire and its Allies will find themselves at the conclusion of the present war, and to make some suggestions for a combined economic policy designed on the one hand to meet the huge liabilities consequent upon the war, and, on the other, to increase the prosperity, comfort and security of the nations and peoples concerned; while, at the same time, affording a means of restraining the harmful activities of the present enemy powers, and of administering to their peoples such a measure of retribution as the Allied Governments may think fit.

From my prefatory remarks you will, I hope, have gathered that, in my view, the after-war problems must be approached with a mind prepared always to remember the scale of the matters involved; to remember that we are dealing, not with individuals, firms, combines, or even separate nations, but with the most powerful league of nations ever known. Consequently, the petty objections, prejudices, and obstacles appropriate to the consideration of the affairs of small bodies are entirely out of place when applied to the economic problems of so vast and powerful a comity as the Entente Powers.

After the war there are many problems to be faced, but of these the most important are the payment of the war debt, the feeding of the people, the provision of work for our ex-soldiers, and the rehabilitation of the devastated areas. What means are we going to adopt? Are we going to saddle our taxpayers with this grievous burden, as the clerk, of whom I have spoken, is saddled with the money-lender's interest? Surely we should avoid this at all costs—and the way is easy.

Within the Allied Empires are tremendous resources, capable of development by means of relatively small capital expenditure into assets of immense value, which could be realised in such a way that the entire war debt could be liquidated, even allowing for post-war borrowings on behalf of devastated France, Belgium, Poland, Serbia, Rumania, and Montenegro. The development of these resources would provide employment for our demobilised armies, either in the field or in the workshop; would render possible the provision of foodstuffs in the huge quantities that will be required by the Allied peoples; would set up homes in parts of the Empire now unpeopled, and would provide a splendid reserve of trained seamen for the Allied nations.

The principle of State development in our Empire for the benefit of State and people has already been advocated in the public press and elsewhere, notably by Mr. Wilson Fox, M.P., of the British South Africa Company, in articles published in the *Times* newspaper of September 28th and 29th, 1916, and in a paper read to this Society on December 13th, 1916. An influential committee—the Imperial Resources Development Committee—has resulted, to which I have the honour to belong, and a very favourable reception was accorded by public opinion to this Committee's manifesto published in the press on February 5th last.

Briefly put, the objects of the Imperial Resources Development Committee are to foster the project of further developing on business lines under State auspices—by means of an Empire Board, working aloof from politics or party—such Empire resources as may prove suitable and obtainable. The resulting profits, whether by way of direct sales of produce or royalties on production, or by way of increased capital value realised on sale, should amply suffice within a reasonable time to pay off the entire war debt without taxation, yet leaving the Empire more prosperous than before. The incidental benefits of such a scheme, to the Empire as a whole and to the producing areas developed, will best appear from a study of the examples which have thus far been considered in greater or less detail by the Imperial Resources Development Committee.

Before embarking upon the consideration of such examples, however, it may be well to revert once more to the essential importance of adopting new methods of finance in the face of a post-war liability of such unprecedented magnitude. Assuming our own war debt to be four thousand million pounds—almost certainly an *under* estimate—that sum works out at about £500 per family. To pay off this £500 would require about 15*s.* per week in interest and sinking fund. How many poor and middle-class families could afford this? Remember, too, that it is easy for the wealthier classes to "pass on" any increased taxation by the process called "cutting down expenses"—a euphemistic term for diminishing other people's earnings by doing without certain services which the other people render.

What hope would there be of money being voted by Parliament and the rating authorities for social reform, in face of such a terrible hole in the national pocket? We know, for instance, that school teachers are underpaid, as compared with members of other professions for which

equivalent training and study are necessary. Workmen's houses, old-age pensions, afforestation, and cheaper telephones, are other instances where the essential money would not be forthcoming. Almost certainly the Poor rate would rise—but with that we should like to dispense altogether.

Under such burdensome conditions, life in Britain would be unbearable for the best of her sons, who would chafe until they broke away, emigrating to some more favoured country. That would only make matters worse.

With these considerations in mind, and remembering the scale of the matters involved, it is clear that new methods *must* be adopted. We turn again, then, to the idea of Empire development, prepared to search the future with prophetic glance and discern, so far as may be, the results of the practical working of a scheme of the nature indicated.

Accepting, then, the principle of State development of Empire resources for the benefit alike of State and peoples, let us next consider certain specific examples of appropriate resources. We shall then be in a position to consider how present Allies, Neutrals and enemies would be affected, and to indicate the lines of a common economic policy.

My present remarks are not, however, to be taken as an official exposition of the views of the Imperial Resources Development Committee, but as conveying my own personal views, more especially as regards certain extensions and economic consequences of the policy advocated by that Committee.

I will first touch briefly upon Mr. Moreton Frewen's suggestion of an Empire Farm, dealt with by him in a paper read recently to the North-East Coast Institution of Engineers and Shipbuilders. The development of millions of acres of new wheat lands, favourably situated as to climate and relatively accessible from Hudson Bay, would in itself be a magnificent achievement. But note the results: by creating enhanced value in such land by preliminary development and preferential treatment, and then disposing of the land, on the gradual payment system or otherwise, we should in the first place be repaying part of our war debt—but there is more than this. Canada would benefit by the added population and commerce, the Empire would be made more nearly self-supporting in respect of wheat, and the manufactures of the home country would find a new market.

It is only just, however, to emphasise that the practical success of the Empire Farm proposal is dependent, in my opinion, upon the imposition in the United Kingdom of an import duty on wheat from countries outside our Empire and our Allies. Such a duty would bring about an immediate increase in the cash value of this fertile soil within the Empire. Land in the Empire to-day only worth a dollar an acre would become worth £20 an acre when provided with subsidised cheap transit, railways, and guarantees that all it produces will find a better market than similar articles produced under any other flag. These advantages will draw the necessary workers; and the Dominion which assists and facilitates this transfer of its land to the Empire Development Board will reap the harvest all new countries covet—a settled well-to-do body of citizens, constituting man power and a widening taxable area.

I would wish to invite your especial attention, however, to other examples regarding which my forty years' business experience has given me an intimate knowledge. The first of these is provided by the British Possessions in West Africa. In addition to mineral wealth in the shape of tin and copper, these Colonies contain valuable areas of timber and are capable of producing cotton and rubber; but these are not the products on which I would particularly lay stress. West Africa is, however, the home *par excellence* of the oil palm, from which the natives obtain two products of tremendous importance. The fruit of this palm comprises an outer pulpy mass which, when boiled in water, yields palm oil; within this mass is a cluster of nuts not unlike small Brazil nuts, and these when cracked yield kernels containing nearly 50 per cent. of the richest vegetable oil known.

The crushing of the kernels to obtain the oil was, before the war, almost entirely a German industry; but steps have now been taken to establish the industry in this country and to eliminate the German interest in West Africa.

All my hearers will be familiar with the recent discussion in Parliament respecting what was called the "Nigerian Sale," the question then being whether certain properties established by Germans should be sold only to Britons and their Allies, or thrown open to Neutrals. The latter course was maintained, contrary to my own views; but it is satisfactory to be able to state that the properties of value were in fact acquired by British firms.

To return to the fruit of the palm: we see, then, that this yields oil called "palm oil," and kernels called "palm kernels," the latter providing when crushed another oil—"palm kernel

oil"—and a residual cake—"palm kernel cake."

All these three products are of the greatest value; the oils are the stock raw material of the soap and candle makers, and in this connection during the war have assumed enhanced importance because the soap and candle makers in their manufactures extract from the oil glycerine, serving as the basis of our cordite.

Palm kernel oil, in addition, is a large ingredient of margarine, and most certainly the consumption of margarine is unlikely to diminish—in fact I hesitate to assign to it any limit. The cake, when blended with molasses and other materials, forms an admirable food for cows and pigs, as the Germans long since discovered.

In the oil palm alone, then, West Africa possesses a most valuable asset, but this by no means exhausts her vegetable wealth; from the Gambia, for instance, come the finest ground-nuts known, large quantities also being produced in Nigeria and the other Colonies. These ground-nuts are also called earth-nuts, pea-nuts and monkey-nuts. From them a most valuable oil can also be pressed, and a cake useful for fodder obtained; but to these I do not attach so much importance as to the palm produce, because of this latter British West Africa possesses a virtual monopoly.

As proof of the value of this monopoly, I cannot adduce better evidence than what is happening at the present time. On account of the importance of palm oil as a source of glycerine, we allow the exportation of it to our Allies, but not to Neutral countries; nevertheless the Neutrals are so badly in want of this oil that their merchants have come to terms with us, and agree to give us the glycerine content of the oil as a condition of being permitted to import it.

When I tell you that the entire supply of glycerine in this country is requisitioned at just under £60 per ton, and the corresponding price in America, for example, is nearer £200 than £150, you will appreciate that the Neutrals consider our oil to be of great value and worth paying a good deal to obtain.

There is, in addition, a small export duty on palm kernels and oil which has been imposed for Colonial revenue purposes, but this applies to exports to all destinations, and does not affect the present arguments.

The only other product of West Africa which need be mentioned here is cocoa, of which enormous and increasing quantities are being obtained year by year. The popularity of cocoa products, such as chocolate, shows no signs of diminution, and we may reasonably anticipate that cocoa will not in the future form a less valuable asset than at present.

Think what it would mean if all these products of West Africa, mineral and vegetable, were controlled for the benefit of the Empire as a whole! Think how huge is the potential profit which could be devoted to the service of the Empire's debt.

One criticism I would here reply to in advance, and that is, the objection that the profit resulting from the development of West African produce under State auspices would be an unfair profit derived from the people, upon whom it ought to be spent by a reduction in the price of the manufactured articles concerned.

In the first place, I would point out that the present prices of the manufactured articles are eminently reasonable. No one, for instance, can cavil at 9*d*. per lb. for margarine, which is the price that has been maintained even in war time. Consequently, the continuance of about the present prices, which forms one element of the proposal, would be quite unexceptionable. Furthermore, were the matter left in private hands, no reduction in price, even of the raw materials, would be at all probable; for apart from commercial reasons which would lead the parties concerned to maintain present prices, there is the fact that no such cheapening of the supply could be brought about by private endeavour as could be effected by State enterprise operating on an almost infinitely larger scale than would be possible to private traders, or even large companies.

There is yet another consideration, namely, that the manufactured article is disposed of to the consumer in such small quantities in the retail trade that a very large margin of profit on the raw materials taken in bulk represents the most trifling proportion of the retail price. Let anyone who doubts this work out what a halfpenny per pound in the price of margarine would represent on the cost of the raw materials manufactured into the margarine consumed in the United Kingdom. At present this consumption of margarine is, approximately, 3,500 tons per week, and a halfpenny per lb. works out at about £16,000 on the raw materials. This is *per week*, and equals a trifle of £800,000 per annum. This is for one manufactured article only, margarine, and is apart from the other manufactures employing West African oils.

The direct profit from the West African produce by no means exhausts the benefits which would result from the possession and the

development by the State of the trade in such produce. In addition to providing most important supplies of food and raw materials for our British industries, the adoption of the scheme proposed would, it is clear, benefit the Colonies concerned most materially.

In British West Africa are about 17,000,000 natives and only 6,000 whites. The proposed development scheme would afford a splendid means of facilitating the civilisation of the natives, as their labour would be harnessed to the chariot of progress and productiveness, and their purchases would to a greater extent than at present be under Government control, thus in time enabling the disastrous gin traffic to be done away with entirely. Means of communication would be improved; schools and model villages built, and, in short, British West Africa would be advanced immeasurably.

The prosperity of the Colonies, moreover, is synonymous with that of our Lancashire factories, and others, which supply the natives with their manufactured goods; in proof of this it will suffice to state that the African merchant, who at present purchases palm produce, reckons to make the major part of his profit, not out of this produce, but from Manchester goods which he sells or barters to the native.

To one point I wish to draw your particular attention, and it is that the West African resources are not undeveloped, although capable of much further development. The oil palm, for instance, now growing wild might well be susceptible of improvement by the application of scientific methods. It is no part of the general scheme here outlined to spend State capital upon wild-cat schemes as yet untried. Every proposal put forward would have most carefully to be scrutinised; but here is a proved success now yielding a handsome profit, and capable of great enhancement. Within the Empire are many other such waiting, almost crying, to be taken over.

Space prohibits my going into detail with regard to other instances; but I may perhaps mention the untold wealth in the supplies of fish within the Empire's territorial waters, of forests hitherto untouched, minerals yet unmined, and crops yet unsown.

Every article and every industry, and every Colony and Dominion concerned, would require special consideration, and the apportionment of the share of the State in the profits. For example, in dealing with minerals as yet undeveloped or perhaps even undiscovered, a policy would be necessary differing largely from that appropriate to vegetable produce. Also, portions of the Empire suited to be the home of white people would require to be developed on altogether different lines from tropical lands, where home life, as we understand it, and the nurture of white children are impossible.

Enough has been said, surely, to convince everyone that the liabilities consequent upon the war can be faced with equanimity if we and our sister States grapple resolutely with the situation and bring to bear the tremendous resources of the Empire.

I would like to add a few words, however, as to fish, and to point out that, although tremendous quantities are already landed and consumed in the United Kingdom, amounting to about 600,000 tons in 1913, these quantities might be greatly increased by extension of supplies, and improved methods of distribution and storage. In my opinion there is almost certain to be a continuance of the high price of meat, especially beef, and a remedy is to substitute a larger proportion of fish than at present in the dietary of our peoples. The seas around our Empire teem with splendid fish. As a Canadian Bluebook well puts it: "To say that Canada possesses the most extensive fisheries in the world is no exaggeration; moreover, it is safe to add that the waters in and around Canada contain the principal commercial food fishes in greater abundance than the waters of any other part of the world." Yet in 1915, according to the same publication, there were only 48 steam fishing vessels; 1,236 sailing and gasoline vessels; 25,105 sail and row boats; 7,740 gasoline boats and 431 carrying smacks engaged in the Canadian Fisheries. These do not include the figures for Newfoundland, in whose cod fisheries 2,000 schooners and 25,000 boats are engaged.

Not the least important aspect of the fisheries question is the large consumption in other countries of cod, herring and other fish, pickled and otherwise; for instance, apart from Germany and North European countries, large amounts are taken by Greece, Italy, Spain, Portugal, and Brazil. Under State auspices, and with a comprehensive system of supply and distribution, a huge world trade could be built up, and care would, of course, be taken to ensure that our Allies received the greatest possible advantage resulting from the increased supplies.

I must not omit to mention the whaling industry, carried on mainly in the waters of the Antarctic Ocean by companies largely

foreign, under licences granted by the British Government. Last year these regions produced 100,000 tons of whale oil, worth £3,000,000, the whole of which was bought by the Ministry of Munitions for use in making glycerine for explosives, and for other purposes vital to the war. This purchase affords sufficient evidence, without further comment, of the value of this Empire asset.

One general feature of State-aided operations such as we are considering, is that special attention would be paid to the welfare of the individual worker. The Empire could well afford to treat handsomely the existing interests and to enlist their co-operation as agents in further development.

This scheme might truly be called a State partnership, where the native producer, the merchant, and the steamship owner would all be secured shareholders, certain of their remuneration, and the State would take no share unless and until the value of the produce in the markets of the world enabled it to obtain a profit in excess of all legitimate cost of production and transit by private enterprise. This as a principle of State policy was unknown in practice until the war, but we are all familiar with the fact that the State, by means of the Munitions of War Acts and the Excess Profits Tax, has made itself partner in every successful business in the kingdom. In the case of all munition firms, after pre-war profits have been made and 20 per cent. added, the rest is the State's share in the partnership. The proposal I am laying before you is that this system should be applied on a broader basis, and that other industries should be made partners with the State in the development of State resources.

Every encouragement possible ought to be afforded to individual effort, and the workers should participate in the benefits without the least taint of exploitation.

But some may say that with a scheme of such unprecedented magnitude there is nothing to guide us in the matter of procedure, engagement of staff and the like. Fears may even be entertained that vital commercial questions would be left in the hands of a college-trained bureaucracy and thereby foredoomed to failure. To this I would reply that we have the experience of the great combines to help us, and can profit by their successes while avoiding whatever may be unfair about their business methods. What is probably the greatest combine in the world—the Standard Oil Company—deals with its staff in a manner, to my mind, wholly admirable. Each person holding a responsible position is specially selected, and is then given an absolutely free hand within certain prescribed limits. The credit of the Company is at his disposal up to a specified amount, to be used in whatever directions he may think fit. This affords to a man of initiative and ability opportunities such as in no other circumstances in ordinary commercial life could be his, for the credit of the combine is so immense.

No doubt occasional blunders are made, and those who fail to fulfil the trust placed in them are superseded; but the point I wish to emphasise is that they are given a chance to show what is in them, and are not penalised for making occasional mistakes. The great and haunting dread at the back of the mind of the ordinary official, as I understand it, is fear of committing his department. Can it be wondered at that lack of initiative is frequently urged against officials burdened with such a dread? Timidity is a logical outcome of lack of responsibility, and that is what the suggested Empire Development Board would carefully avoid.

How are these proposals likely to be received by that very important department of the community—organised labour? I would answer this by drawing attention to the recent conference of the Labour Party, which emphatically protested against the imposition of heavy taxes to meet the liabilities of the war, but recommended instead conscription of wealth. Here is a way in which the State can conscript wealth without hurting anyone—that is, the State can conscript the State's *own* wealth and make itself wealthier still.

Taking it as proved then that development of Imperial assets on the lines suggested is desirable in principle and feasible in practice, let us turn our attention to some allied and consequential economic questions.

It is clear in the first place that the foregoing proposals would form but a part of that closer Empire union which all anticipate will succeed the war.

The component portions of the Empire which have sent their sons to battle side by side and to work in the same factories, and which have taken upon themselves burdens for the commonweal, are bound to treat one another in the future on more favourable terms than they give to the present Neutral States. There seems an almost general consensus of opinion that Imperial Preference is a necessary consequence of the present war, and, as announced in the *Times* of

February 14th, Lord Balfour of Burleigh's Committee on the Paris Resolutions has presented an interim report unanimously in favour of establishing Imperial Preference. Such a preference would naturally be so arranged as to assist Empire development.

On grounds of sentiment and security alike there seems no other course in order to render the Empire self-supporting, and to draw closer in peace by economic methods the bonds of unity which have proved so valuable and so magnificent in war.

The extent of the preference is a matter for consideration by delegates from the Empire, but we shall not go far wrong in assuming for the sake of argument the Canadian figure of 33⅓ per cent. rebate in all Customs duties in favour of goods produced within the Empire.

This in itself is not enough to ensure, not merely the maintenance but the extension of supplies from the Empire of what may be termed vital articles, whether in the nature of food or raw material. The end to be attained is that the Empire should be self-supporting in all essentials. Already these essentials are provided in large proportion, as, for instance, wheat from India, Canada and Australia, but it is necessary to ensure that the proportion shall be sufficient to enable the Empire to "carry on" in time of stress without external supplies.

The most workable method for bringing about this consummation is, in my opinion, to impose a heavy import duty on supplies coming from *outside* the Empire as soon as the supplies derived from *within* the Empire reach half of the amount which has to be imported. It is of no use shutting out foreign supplies until we know that in large part we can rely upon our own. On the other hand, when that point has been reached, we can, by placing our Imperial producers in a favourable position, enable and induce them to expand their activities to such an extent that not merely will they within a comparatively short period of years entirely supply our British requirements in the articles concerned, but produce a surplus exportable elsewhere.

In cases where the Empire producers did not supply 50 per cent. of the imported requirements of this country, but did produce, say, 40 per cent. of this amount, it is clear that they would spare no effort to bring their production up to the necessary figure, knowing the prize that would be theirs on attaining that figure.

It would be worth while to sink capital in the production of an article in the Empire with the knowledge that by increasing that production by 25 per cent. the industry would be placed in a much more favourable position than at present. By this means, therefore, we should, within, say, ten years, place our Empire in a position to rely absolutely upon itself, and within a few years more to enter other markets in a very strong position.

It should, however, be made clear that other measures would be necessary in the case of articles of which it is desirable to foster the production within the Empire, but which at present are not grown to anything like 50 per cent. of our requirements.

Hitherto we have spoken more particularly of our own Empire, but the schemes here outlined, both of development and of preference, could readily be adopted by our Allies. The mineral wealth of Russia is fabulous, as also the value of her forests, fields and flocks. These resources afford a splendid field for British energy and capital, and concessions in this direction might well be obtainable, as also a preference in the carrying trade with Russia, in exchange for the products and manufactures which could be offered as a result of a scheme of Empire development under Imperial Preference. Imperial Preference would thus grow into Allied Preference, assisted by a scheme of Empire development.

France, in return for the supplies of foodstuffs and other raw materials which our development scheme would put us in a position to supply, might grant us tariff concessions in her own home markets—and the wonderful purchasing power of the French is sufficiently well known for the value of such a concession to be realised by all.

Belgium's home requirements will also be very great for a long time, and State-controlled resources in the British Empire would provide an admirable source whence these could be supplied. Moreover, in Africa, France and Belgium together possess territory of much greater area than the whole of British West Africa, having railways and systems of irrigation made and projected. These Colonies comprise resources capable of development on lines similar to those of our own, and combined or allied schemes would merit most careful consideration by the Board of Development which the Imperial Resources Development Committee desire to have constituted.

Let it not be thought, however, that I suggest driving hard bargains with our splendid Allies; the concessions I have touched upon would be granted freely by them or not at all, after we

had given first. Both as to the fish, West African, Indian and Colonial products, which would result from the development scheme indicated, and as to the preference, I would admit our Allies with our Empire, in the certain hope that they would, in their turn, grant us concessions in their markets and in their territories as freely as we gave them in ours.

Let us now try to contemplate the outcome that might well result of a league of Allied States, self-reliant, self-supporting, self-sufficing; freed from the burden of the war debt by schemes of development which would keep their population employed, their factories busy, their steamships filled and their citizens prosperous. The existence of such a comity, by reason of its strength, not merely in a naval or military sense, but economically and commercially, would go far to render war impossible.

Such a union would be enabled to impose its will upon the world, but its very diversity of peoples would afford sufficient guarantee against any narrow-minded action on its part. The present enemy Powers, deprived of colonies and allowed to trade only on sufferance, could never regain their former position in the countries of the Allies. Peaceful penetration on their part could be stopped as effectually as the road to Calais was barred, and, if necessary, a licensing system could be continued as regards trade in materials of vital importance. This last point, however, goes rather beyond the scope of my subject, and I will abstain from pursuing it further on the present occasion.

It remains to deal with one or two criticisms not already considered. Mention has already been made of the possible objection that individuality and initiative will be killed by the institution of monopoly, and I need only add that, so far from initiative being diminished, it would be increased by the friendly rivalry between different branches of the organisation to produce the best results. Considerable rewards would await the most successful—not necessarily those branches which actually brought in the most hard cash, but those who had made the most in the best sense of the resources entrusted to their care.

A further objection is that the policy outlined reeks of "Socialism." This much-abused word covers a multitude of policies—in fact, as many as there are Socialists; but, surely, we are all Socialists at heart, in so far as we strive for the good of the entire social organisation. In my view, the policy advocated affords the best antidote to the vicious doctrines commonly described as Socialism, which have as their basis the plundering of the successful for the benefit of the glib.

Yet another objection is that the proposed policy violates the principles of Free Trade. To this I would reply that the logical outcome of the policy is a gigantic scheme of Inter-Allied Preference, under which the trades that matter would be freer than they have ever been before, in that they would have liberty combined with safety in a wider sphere.

If any should urge that it is wrong for the State to undertake risks, and that undue risks attach to the schemes proposed, the answer is that it was wrong to spend money on the Assuan Dam, on the Indian State Railways, on a Government Postal Service, or if you will, on the British Navy.

One other possible misapprehension remains to be dealt with, namely, that to institute a scheme of Empire development it is *necessary* to lump together the entire war debts of the several Dominions with those of the Mother Country. Such a course might be adopted, it is true, after mature consideration, but this is in no sense an essential feature of the scheme, and for that matter such a scheme could be undertaken on behalf of any one or more of the several debts contracted. What is wanted is the institution of a Development Board, charged in the first instance with the repayment of the debt contracted by Great Britain. The Dominions would, in all probability, gladly join in, and arrangements to that end would be easy to make. To such a Board would be handed whatever resources might be offered by the several Governments of the Empire, or by private persons or companies.

The relations of this Board to the several Governments of the Empire would be such that, while holding itself quite aloof from all politics and secure from political interference of any kind, the Board would be able to bring before the various Parliaments of the Empire such legislation as might be required to carry out its schemes.

In conclusion, I would urge with all the force at my command the imperative necessity of this question of the repayment of the war debt being considered with the most open of minds by the great War Council, which is shortly to meet in London.

If, as a result of their deliberations, the several Dominion representatives return to their homes with the news that a Board of Development is to be set up to consider proposals, and to prepare for action on the lines I have indicated, the next

step will be that the several Dominions and Colonies will gladly come forward with the cry "Here are our resources; we give them as we have given our sons and our treasure for the service of King and Empire; take them and use them."

DISCUSSION.

The Chairman (Mr. W. A. S. Hewins, M.P.), in opening the discussion, said nobody knew what the financial burden on the Empire would be as a result of the war, but as far as could be seen at present it would overtop £4,000,000,000. Most people who had studied the subject would agree that our war finance marked a new departure in the financial history of the country more momentous than it had ever been before. The country would never go back to the old level of expenditure. It would pay off its debts and reduce the demands upon its purse in one way or another, but the war would be found to have lifted the level of expenditure. He thought a good deal of our finance had been managed on the assumption that there was some mysterious capital draft upon which it was possible to draw indefinitely without paying any regard to productive energies. There could not be a greater fallacy, and there was no way in which our obligations after the war could be met except by developing the resources of the Empire. About eighteen years ago he gave three lectures in the Hall of the Society on Imperial Policy. Those lectures arose out of the situation in Germany, where they were revising their general tariff, just at the beginning of the development of the German policy which had resulted in the present war. He then hazarded the opinion that it might make for peace as well as for the productivity of the Empire if our resources were organised, and, looking back over the eighteen years that had elapsed since, he did not think there was anything material left of the system that was in being at that time. The philosophies that underlay the policy upon which our Imperial concerns were conducted had been proved on many a battlefield to have been quite as false as anything that could be entertained. He also remembered giving a course of many lectures in the Hall of the Society extending over several years on the historic Acts of Parliament under which the wages of labour were regulated, and he then hazarded the suggestion that force of circumstances would bring English people back to their historic traditions. He did not then think that Mr. Lloyd George would announce in the House of Commons, as he did on the previous Friday, that they had returned to them. The lines of policy which the author had sketched out for the organisation of the Empire had been a subject of the greatest controversy, but he had never been able to understand why. The author had mentioned that the Committee on Commercial and Industrial Policy, under the chairmanship of Lord Balfour of Burleigh, had come to a unanimous decision in favour of the adoption of a policy of preference, and that resolution was agreed to, not only by people like himself, who had always been identified with that policy, but by Lord Balfour, by prominent Free Traders, and by representatives of labour. All parties combined to agree to that historic policy, but it must be remembered that it was a historic policy, because, although this country abandoned it for a short period, the Dominions had never done so. It was the system upon which the British Empire grew from the reign of Queen Mary up to modern times. The whole system which people had thought was so deeply rooted in English life had crumbled under the pressure of the war, and it was now necessary to consider on what system it should be built up again. The author had suggested some of the lines on which it should proceed. It was perfectly obvious that the old notions of a purely individualist organisation of economic life had been knocked to pieces by the war. He had not the least doubt that if, when the Imperial Conference took place, the British Government went before the Conference in no niggling spirit, but with the whole-hearted generous determination to adopt any method which would bring the Empire closer together and help to develop its resources, it would meet with the greatest degree of co-operation possible from the Colonial Premiers. It ought to be made clear to the whole world that they did mean definite things. They did not mean internationalism in trade or commerce, but they meant first and foremost the British Empire. In the second place they meant, he trusted, a permanent economic alliance between the British Empire and those who had fought with us. There was a good deal of talk in certain quarters about the extreme desirability of maintaining the old cosmopolitan relations. He trusted the country was not going to do anything of the kind. The theory that, by throwing our markets open to everybody peace would be guaranteed and prosperity secured, had been proved by the war to be incorrect. All that was done by pursuing a policy of that kind was to allow an aggressive Power to permeate our trade, commerce, and finance, and undermine the very existence of the Empire. There was nothing hostile, unfriendly, vicious, or aggressive in the attitude he suggested; but the Empire should, without any feeling, though in a quiet businesslike way, lay down as the principle of their action—the Empire first and all the time, then our Allies, and the other people where they could get in. If the Empire acted upon these principles he believed a great Western alliance would be formed between the British Empire, France, Italy, and our other Allies, and it would be impossible to measure what that would mean for civilisation. But it

must all rest upon the economic basis, and it must not be supposed for one moment that it was possible to substitute any policy which would dispense with the economic organisation of the resources of the Empire. Self-government was no good unless the self-governing body controlled its fiscal and economic policy; and, provided that was done, the other institutions would grow and flourish. It was unnecessary at the moment to think too much about the future, because the policy of the future would be largely made in the furnace of the war. He hoped the organisation and mobilisation of our Imperial resources would not be delayed until peace was declared, but that they would be carried out at once for the purpose of carrying on the war to a successful conclusion.

MR. H. WILSON FOX, M.P., hoped the people of the country would approach the subject with such determination that they would not allow the accomplishment of the great end in view to be prevented because all sorts of difficulties were in the way. Many of the difficulties were academic, resulting from a system which had become crystallised. That system must not be allowed to interfere; it must be remodelled or, if it could not be remodelled, swept away and a new organisation created in its place. One of the difficulties connected with the questions dealt with by the author was that of Treasury and Parliamentary control. Nobody could deny that there must be some measure of Parliamentary control over expenditure, but he thought it was necessary to divest our minds of the idea that the control must be exercised through the Treasury in the old way, because, if it was, the new organisation would be strangled from its birth by bonds of red tape. It was necessary to find new methods of Parliamentary control for checking the work of the great organisations to be set up, and he thought the solution was to be found on the lines of associating the great Dominions with the work. For instance, if the Imperial Board of Development was selected by a future Imperial Council or Parliament, then the question of patronage by the Government of the day would be largely swept aside. Similarly, if the control of individual branches of the organisation were entrusted to statutory authorities which had the right to spend public money, under the supervision of commercial auditors responsible to Parliament, many of the difficulties of the present system would be got rid of. If the country was satisfied that the work should be done it was its business to get over the difficulties raised, and for that purpose he hoped those present would support the view that at the earliest possible moment a Committee should be appointed by the Government with the express object of devising means whereby the aims in view could be successfully carried out.

MR. MORETON FREWEN said the United States was at the present day confronted with a most appalling food problem. He had always been an avowed Protectionist, but the United States had pushed manufacturing protection to such an extent that they had upset the natural balance that should exist in a country between agrarian and industrial conditions, and they had so congested their people in towns for the purpose of their industrial system that it was impossible any longer for the farmers of the United States to supply the food that was required. As a result of the demands made by the great industrial centres in the United States, the food of the Empire was being sent to the States, and unless something radical was done to protect our food supplies he prophesied that in the next ten years the entire cattle trade of Ireland would go to New York. There had been an enormous growth in the value of land in Canada since 1878, and nothing would induce him to believe that the pressure of 100,000,000 people on the Continent of North America would not raise prairie values in the north-west, now perhaps one dollar an acre, to £20 an acre in the next twenty years. In 1913 the immigration of settlers, chiefly from the United States into Canada, was such that they took up in homesteads over seven million acres, and in that way Canada gave away property possessing a potential value of at least £150,000,000 sterling. The Empire Resources Committee was under a debt of obligation to the author for his suggestion that the fisheries of the Empire should be nationalised. In any scheme brought before the Board which it was hoped would be constituted, it was desirable in the first place to deal with an industry in which the return on capital was exceptionally large. In this country the gross yield on the £10,000,000 invested in the fisheries was more than £10,000,000 a year; while in Canada the gross yield was £7,000,000 a year on an invested capital of £5,000,000. In the United States also there was more than 100 per cent. gross return on the capital invested in fisheries. The capital of the British Isles was reckoned to be £14,000,000,000, and the gross return on that, excluding duplicate entries and imported raw material, was only 9 per cent., compared with more than 100 per cent. from our fisheries. He thought it was also fair that the State should be asked to encourage fisheries, because, while the individualist farmer cultivated his fields and reaped his own harvest, a very large part of the expenditure of money, both in the United States and Canada, on ocean fisheries was connected with operations such as hatching salmon and lobsters, and no individualist who was not a crazy altruist would hatch lobsters and turn them out in the ocean on the chance that he would benefit by their capture. The State must do those things. If cold-storage plants could be erected in every town and we took advantage of the mighty

harvest of the ocean to store during the months of abundance against the gales of winter, and were the State given a profit of, say, 1*d*. a lb. on the sales of fish, the consumption would be very largely increased.

Mr. A. M. Samuel said he did not look with apprehension upon the great debt that was being piled up as a result of the war. From an economic point of view it was simply a capital expenditure of £5,000,000,000 for the extension of national machinery, and as a business proposition it would pay if the sources of supply in the Empire were linked up. During the ten years before the war £500,000,000 was lost in limited liability schemes of a wild-cat character, and he thought such money in the future could be diverted to the development of national resources. He also suggested that the railways of India might be profitably extended. It was disastrous that this country had to depend on the United States for certain classes of cotton, and, as American requirements for cotton were growing, this country would find itself faced with an increasing shortage of supply. This could be adjusted by an increase of British-grown cotton. He also supported the suggestion that had been made with regard to fisheries, and thought that the Government might with advantage provide refrigerators for the storing of fish at every railway station throughout the country. Indian hides also should not in the future be sent to Hamburg or the United States to be tanned and come back to this country to be made up. He was totally against the principle of bringing only dead meat to the country, leaving the valuable hides and the offals to the foreigners.

The Hon. F. W. Young (Agent-General for South Australia) said the war had enabled the people of this country to appreciate how the British Empire controlled the assets of the world, and he hoped that would make us stronger in our attitude to all other nations in the future. With regard to the question of State assistance in the development of those assets, it was necessary to be careful not to bring the State too intimately into the matter. He still believed a great deal in the individual, and thought the proper way to work the scheme was that the suggested Empire Board should have as little as possible to do with the actual work of development, and still less to do with the profits. Human effort was limited by population, and by the extent to which individuals made use of their energy and abilities. People were already more or less engaged in development and production, and one of the problems of the future was to develop the energies of the people throughout the Empire to the utmost of their capacity. The war had brought classes together in a way that nothing else could have done; there was a greater disposition on the part of capital and on the part of labour to work together hand in hand, and in that way there would be a greater production in the future. He hoped that, as suggested, the central concern would get on very happily with all its employees, but it had not been proved that because a man was employed by his country he was any more contented or less likely to strike. Men appreciated that they were not only employees but voters, and, feeling the additional power, were prone to exercise it. In the newer countries it had been found necessary for the State to interfere to a certain extent by finding part of the initial expenditure involved and offering special inducements to men to go into new concerns, in the hope that ultimately those men would be successful, and in that way would help to build up the wealth of the country to which they belonged. If the Empire was to be developed as a whole, facilities must exist so that the people and the wealth of the Empire could pass freely from one part to the other without suffering any disabilities. Unfortunately, this condition did not exist at the present time. If a person in this country, with a view to developing the Imperial assets of Australia, invested money there, he had to pay income tax to the extent of 13*s*. in the £, because he paid income tax not only in this country but also in Australia. That grievance should be remedied. If the resources of the Empire were to be pooled, it should be possible for a man who had his wealth in any part of the Empire to transfer it to another part without having to pay income tax twice over.

The Hon. Sir John McCall (Agent-General for Tasmania), in proposing a hearty vote of thanks to Mr. Bigland for his paper, thought that one difficult question that might arise in connection with the scheme suggested was that the control that would be necessary over the large amount of capital involved must be something more than the present Imperial Government control; but no doubt it would be easily possible to solve that difficulty.

Mr. Byron Brenan, C.M.G., seconded the motion, which was carried unanimously, and Mr. Edward Dent having, on behalf of the Committee of the Colonial Section, thanked Mr. Hewins for presiding, the meeting terminated.

POTASH FROM ALUNITE.

It appears from a Bulletin recently issued by the United States Department of Agriculture that considerable interest is being evinced in processes for the recovery of potash and other products from alunite. This mineral is a hydrous sulphate of potash and alumina, and it occurs in important deposits both north and south-west of Marysvale, Utah.

Difficulty in effecting a complete separation of the potash after the ignition of the mineral has been experienced both in the laboratory and in factory practice; and since the material must be regarded as a relatively low-grade potash carrier, cheapness and efficiency in the extraction of the potash are essential to its successful commercial development.

Eleven samples of light-coloured alunite from the undeveloped but readily accessible area north of Marysvale were ignited at different temperatures and the residues subsequently leached with water. A temperature between 750° and 800° C. was found to be best for the complete extraction of the potash with the minimum amount of water. Temperatures above 800° C. caused a fixation of the potash, particularly where the samples contained much silica. An experiment to test the influence of fineness of grinding on the subsequent extraction of potash from alunite showed that nothing is to be gained by grinding the material finer than 60 mesh.

Since practically all of the constituents of high-grade alunite have their market in the East, it is suggested that it would prove more economical to ship the mineral east, taking advantage of the lower freight rate on raw material, than to manufacture the finished products near the mines. The freight charges even then, however, are so great as to leave a very narrow margin of profit on the products in normal times.

Copies of the Bulletin may be obtained at a cost of 5 cents each from the Government Printing Office, Washington, D.C.

BAY RUM INDUSTRY IN THE DANISH WEST INDIES.

The cultivation of the bay tree and the extraction of the oil from its leaves provides for the island of St. John, Danish West Indies, its most important industry; and the distillation of this oil and its subsequent manufacture into bay rum furnishes for the sister island of St. Thomas its only article of local manufacture and the most important of all its exports.

According to a report by the United States Vice-Consul at St. Thomas, approximately 4,000 quarts of bay oil are produced in St. John annually, the greater part of which is sent to St. Thomas, from which it is estimated there is manufactured for export purposes about 60,000 cases of 12 quart bottles each of bay rum. The St. Thomas bay rum, which is considered the best on the market, is sent to all parts of the world. The greater part, however, is exported to Jamaica and to Panama, whence it is transhipped to the countries on the west coast of South America.

The requirements for the extraction of the oil from the bay leaves, and its later manufacture into bay rum, are not of sufficient importance to warrant a special interest on the part of manufacturers of this class of machinery, inasmuch as the only important appliance for which there might be a very limited market would be a still that could extract a greater quantity of oil from the leaves than is obtained at present by the crude methods employed, and one that would automatically separate the oil from the water. For the bay rum that is exported from St. Thomas, the cases, bottles, etc., are all imported from the United States, with the exception of the corks, which come from Spain.

Although bay trees can be grown over the greater part of the island of St. John, only about 50 acres are devoted to its cultivation. The pickings of the first few years should yield about 25 lb. of leaves to a tree annually; but after the tree has reached its maturity at least 100 lb. can be counted on providing weather conditions are favourable. A bay tree reaches its maturity when about ten years of age, and under ordinary circumstances will continue to bear leaves for fifty, sixty and seventy years. According to the opinion of experienced growers, three pickings a year bring in the best yield and create conditions that favour the superior quality of the leaf.

Last summer bay leaves sold for ¾*d.* per lb., but in normal times the price is 1*d.* The price of the oil (18*s.* 9*d.* per quart) is considerably less than that ordinarily received, and because of the slack market in St. Thomas, where the oil is usually sent, and the failure to find buyers abroad, large quantities of the leaves are being allowed to go to waste. The retail price of bay rum in St. Thomas is 1*s.* a quart. No customs duty is levied on any article of export from these islands.

CORRESPONDENCE.

HENNA.

The following remarks on the botanical history of henna will, I feel, add to the interest of the extract given in the *Journal* of March 23rd from the Italian *Annali della R. Stazione Chimico-Agraria Sperimentale di Roma.*

Henna is the trade name of the *Lawsonia inermis* of Linnæus, the *L. alba* of Lamarck, commonly known as "the Egyptian Privet" and "the Jamaica Mignonette," a plant of the Natural Order Lythraceæ, or Willow-worts, of which the lovely "Purple Loosetrife" [the "Lysimachia" of Pliny] is the species best known to English people. It is said to be a native of Northern Africa, from whence it has spread into Palestine, Syria, and Persia, throughout India, and even into China, and *across the Atlantic* into the West Indies. It is the *gopher* of the Old Testament translated in our Authorised Version [Song of Solomon i. 14 camphire: "My beloved is to me as a cluster of

camphire in the vineyards of Engedi"—where it still abounds. It is the κύπρος of Dioscorides I. 24, and the "Cyprus in Egypt" of Pliny XII. 22 (51). It is mentioned by the earliest Arabic writers on the botanical drugs of the East, and by the earliest modern European botanical explorers and writers, as by Belonius and Rauwolf in the sixteenth century A.D. The Homeric phrase, "Rosy-fingered Ἠώς" [the Sanskrit *ushas*, "brightening," and Ushasa, "Aurora"] also is recognised as obviously referring to the almost universal use by the women of the East of henna for colouring the tips of their fingers. The young girls of China use it to paint a rosy stripe between their eyebrows. It is also used throughout the East to redden the beards of the men, and to paint the manes and tails of horses. It is used also as a medicine; the roots made into a poultice for sore, war-worn feet, and as an application to ulcers; and the powdered leaves internally in leprosy; but, so far as I have observed, with little efficacy. Its most interesting use is in burning the seeds as an incense to ward off evil spirits.

The word "Henna" is the Arabic *hinna*, in Persian *hina*, in modern Greek χίννα, its Arabic name being connected with the verb *hana*, "to become queen."

GEORGE BIRDWOOD.

NOTES ON BOOKS.

A SCHOOL RUSSIAN GRAMMAR. By E. G. Underwood. London: Blackie & Son, Ltd. 2s. 6d. net.

A PROGRESSIVE RUSSIAN COURSE. By P. M. Smirnoff. London: Blackie & Son, Ltd. 3s. 6d. net.

As a natural consequence of the closer relations between Great Britain and Russia, a remarkable stimulus has been given to the study of the Russian language in this country. Last year classes were established under the London County Council, and by independent institutions both in London and at various other centres throughout the country; and in one at least of the Scottish universities a holiday course in Russian was held for the first time for teachers. It is not very easy to obtain precise figures of the numbers of students of Russian in Great Britain; but the statistics of the examinations of the Royal Society of Arts may probably be regarded as a fairly sure indication of what is taking place generally in this direction. In order to encourage the study of Russian the Society has for nearly thirty years held examinations in this subject; but the number of entries had always been disappointingly small, and in 1915 no examinations were held. Last year, however, it was announced that they would be held again, and no fewer than 127 candidates entered their names.

One of the difficulties with which teachers of Russian had to contend last year was the absence of good grammars and text-books suitable for young English students, and there should be a considerable demand for the two volumes before us. Mr. Underwood sets out clearly the main outlines of Russian grammar, and one who has mastered the book should be able to read simple Russian. Mr. Smirnoff's "course" is divided into thirty lessons, with a supplement containing simple selections from Russian prose and verse, and he claims that a pupil who has carefully worked through the book should have a sufficient stock of words to carry on an ordinary conversation in Russian.

GENERAL NOTES.

RUSSIAN EXHIBITION.—An Exhibition, descriptive of the industries, art, literature and customs of Russia, will be held at the Grafton Galleries, Bond Street, W., during May. The object of the Exhibition is to give the English public an opportunity of learning about Russia, her people, art and literature, and to demonstrate the opportunities that exist for closer friendship and trading relations between England and Russia. For the benefit of all seeking information about Russia, a Commercial Intelligence Bureau will be opened under the direction of Baron Heyking. The proceeds of the Exhibition will be given to the Anglo-Russian Hospitals, which, during the past year, have done excellent work under the Russian Red Cross on different Russian fronts.

COTTON STANDARDS AVAILABLE FOR GROWERS.—In an attempt to produce a more exact classification of cotton in place of the approximations to grades now often employed in gin, street, and warehouse sales, the Office of Markets and Rural Organisation of the United States Department of Agriculture is co-operating with the States Relations Service of that Department in placing in the hands of county agents in the cotton-producing sections, sets of practical forms of the official cotton standards of the United States. The forms are furnished only after the agents have given satisfactory assurances that they will be kept in a place accessible to cotton growers, in the care of a competent custodian who does not profit directly from trading in cotton. Each set of the practical forms consists of the nine grades of white cotton. They remain the property of the United States Government. In arranging for the keeping of the standards in the counties, such agencies as banks, chambers of commerce, boards of trade, and stores whose proprietors do not trade in cotton have been approved. It is believed that the presence of a set of the practical forms in each county, where farmers may examine and become familiar with them, will be a valuable educative force in grading.

COTTON MACHINERY IN JAPAN.—According to an extract from the Japanese press, recently forwarded by H.M. Commercial Attaché at Yokohama, Japanese cotton-spinning companies have decided to investigate the possibility of using American machinery in their mills. Hitherto Japan has relied upon United Kingdom manufacturers for supplies of spinning machinery, in the use of which both her engineers and operatives have been trained. The extent of purchases in the United States already decided upon is estimated at 200,000 spindles, and delivery is expected within five or six months of placing orders. It is stated that difficulties in obtaining supplies from the United Kingdom are responsible for this development. Although this loss of business, as is suggested, is primarily due to the war, it should be an indication to British makers of this class of machinery that they are not indispensable in the Far Eastern markets, and that unless they are making adequate preparations to hold their own after the war, they will by no means have a field to themselves where hitherto they have thought themselves superior.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. :—

APRIL 18. — HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance." SIR GEORGE THOMAS BEILBY, LL.D., F.R.S., of the Fuel Research Board, will preside.

APRIL 25.—SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

MAY 2.—J. C. SHENSTONE, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future."

MAY 9.—PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

MAY 16.—SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

INDIAN SECTION.

At 4.30 p.m. :—

THURSDAY, APRIL 19.—R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products."

Date to be announced later :—

D. T. CHADWICK, I.C.S., "The Future of Indian Trade with Russia and France."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

MAY 1.—PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

HOWARD LECTURES.

Monday afternoons, at 4 p.m. :—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Cheap Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 2...Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. R. Seligman and Mr. P. Williams, "Further Notes on the Action of Acetic Acid on Aluminium." 2. Mr. R. Brightman, "Nitrated Castor Oil."

Engineers, Society of, at the Geological Society, Burlington House, W, 5.30 p.m. Mr. A. M. Arter, "Ball Bearings."

Geographical Society, Burlington-gardens, W., 5.30 p.m. Captain A. J. A. Douglas, "Two Journeys in the High Atlas."

TUESDAY, APRIL 3...Röntgen Society, at the Cancer Hospital, Fulham-road, S.W., 8.15 p.m. Mr. G. Pearce, "The Future of the British X-Ray Industry."

Electrical Engineers, Institution of (Local Section), 17, Albert-square, Manchester, 7 p.m. Lecture by Professor E. Wilson.

(Scottish Section.) 207, Bath-street, Glasgow, 7.30 p.m. Mr. J. Shepherd, "Some Points in connection with Engineering Specifications."

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Discussion on Mr. E. M. Lacey's paper, "The New Electric Power-house at Birchills, Walsall." 2. Messrs. P. V. O'Brien and J. Parr, "The Coolgardie Water-supply, Western Australia." 3. Mr. P. V. O'Brien, "Water-supply in the Interior of Western Australia."

Photographic Society, 35, Russell-square, W.C., 7 p.m.

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. A. Ezra, Lantern exhibition illustrating Big-Game Shooting in India. 2. Mr. R. H. Burne, "Notes on some of the Viscera of an Okapi. *Okapia johnstoni*."

Colonial Institute, Caxton Hall, Westminster, S.W., 8.30 p.m. Address on Canada, by Lord Shaughnessy.

WEDNESDAY, APRIL 4...Aeronautical Society of Great Britain, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. A. B. Young, "Magneto Electric Ignition on Aircraft."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. 1. Mr. V. B. Crowther Beynon, "Notes on Some Family Relics of the Jacobite Rebellion, 1745." 2. Dr. P. Nelson, "Some English Mediæval Embattled Alabasters."

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FRIDAY, APRIL 6, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, March 6th, 1917; Mr. A. D. STEEL-MAITLAND, M.P., Under-Secretary of State for the Colonies, in the chair.

THE CHAIRMAN, in introducing the reader of the paper, said that M. Horn was not only well known in business circles in this country in connection with the Belgian Congo, but those interested in missionary enterprise had reason to be familiar with his work and to be glad of it. The meeting was also favoured with the presence of M. Renkin, the Colonial Minister of the Belgian Government, to whom he was sure they would accord the heartiest welcome.

The paper read was—

THE ECONOMIC DEVELOPMENT OF THE BELGIAN CONGO.

By M. HORN, LL.D. (Brussels).

Few questions to-day occupy a more prominent position in our minds than those relating to the economic resources of the nations between whom the present war has established new or closer ties.

A fresh and acute interest has arisen as to the commodities which these nations are, or will in the near future be, in a position to produce for their own and each other's requirements, and as to the outlet which they will afford each other respectively for their surplus production.

Although the contribution which the Belgian Congo can offer, both as a source of supply and as a market, is as yet comparatively small, it may be found of sufficient importance to be taken into account in the consideration of these great problems.

It is for this reason, I take it, that the Council of the Royal Society of Arts, when they did me the honour of requesting me to read a paper on the Belgian Congo, suggested that my subject should be the economic possibilities of that Colony.

I shall, therefore, this afternoon refrain from making more than a passing reference to the political history and administrative organisation of the Belgian possession. Notwithstanding the place which the war occupies in our thoughts, I shall say nothing of the part which it has been the duty, privilege and glory of the Congo Army to take in repulsing the enemy's unwarranted aggression, and evicting him from the Cameroons and from German East Africa.

Besides, the economic development of a country of the magnitude of the Belgian Congo affords in itself an over-abundant topic for the brief space of a paper.

The size of this Colony, exceeding 900,000 square miles, is approximately equal to the combined area of the British Isles, Belgium, France, Portugal, Spain, Germany, Switzerland, and Italy, and it affords a variety of natural conditions and resources hardly less great than that which we all know to exist in the last-mentioned group of countries.

A considerable number of volumes and pamphlets have been written on the Congo, and from these and from the verbal reports of men who have been "on the spot," it would be easy to make a selection of the most conflicting opinions.

Nobody can boast of having actually seen and of thoroughly knowing more than a small portion of the Colony. Officials, missionaries, and traders, whose sphere of action is necessarily restricted, have the natural propensity of judging the whole of this vast country by the particular regions with which they have become familiar, and of which perhaps the least attractive, viz. the Lower Congo, is the most generally known. Even the most active traveller can only have visited strips of land alongside of a limited number of highways and tracks. Moreover, is it not a general rule that we can only find what

we are seeking for? It is only too easy to pass beside even unhidden riches without suspecting their existence. Of course, personal achievements and disappointments, joys and worries, as well as the state of our health, to a large extent influence our estimate of the things we observe.

Those who are in the best position to form an independent opinion based not only on direct experience, but also on information gathered from numerous and varied sources, will, I think, agree that, in a general way, a more accurate impression is conveyed by Stanley's writings than by the great majority of later publications.

Stanley, let us remember, had travelled very slowly right across the country, making observations and drawing inferences, with an unprejudiced and marvellously perspective mind. As is frequent with men blessed with the gift of imagination, he appears to have underestimated the time which would be required for the possibilities he had recognised to become realities. But fresh evidence is continuously accruing in support of the conclusion at which he arrived forty-two years ago, viz., that this area, of which he was the principal discoverer, "excels all other known lands for the number and variety of precious gifts with which Nature has endowed it."

It may be assumed that almost every kind of mineral wealth will ultimately be discovered in some part or other of the Colony.

Amongst those of commercial interest the best known at present are the copper and tin deposits of Southern Katanga, the goldfields of the north-eastern districts, the coal-seams of the Lukuga (Tanganyika district), the diamondiferous alluvia of the Upper Kasai, and the conspicuously abundant resources of iron ore of the Uele and Ituri.

Elsewhere there are definite indications of copper, gold, lead, diamonds and oil, and there can be no doubt that more widespread and fuller prospecting will lead to many fresh discoveries of mineral wealth in the enormous mountainous crescent which encircles the Congo basin.

There is everywhere abundant material for building and road-making. In all probability kaolin will be some day exported from the coastal region. A fear which obtained until recently that there might be a deficiency of lime for the manufacture of cement and for agricultural purposes has since been dispelled.

To most minds, perhaps, the mention of the Congo will conjure up glorious visions o primeval tropical forests. Although large stretches of such forests are less frequent than may be commonly believed, yet the exuberance of the natural vegetation can hardly be exaggerated. The Congo contains practically inexhaustible stores of wood and fibrous material—fibres suitable for the manufacture of bags, ropes, and brushes; wood in abundance for fuel and timber, ebony and mahogany, besides tanning and dyewood.

Need I mention the rubber trees and vines, the reserves of which Nature indefatigably replenishes?

Unlimited supplies of gum copal are embedded in the marshy regions of the central districts.

Perhaps the most valuable assets amongst this vegetable wealth are the oil-bearing plants, the most conspicuous of which is the oil palm (*Elæis guineensis*), scattered by tens of millions in clusters, groves and forests, over nearly the whole of the Colony. In this connection it may be of interest to note that an opinion current in British West Africa, and which may be well founded there, viz. that the oil palm will not thrive beyond a comparatively small distance from the coast, by no means applies to the Belgian Congo, where luxuriant palm forests are found more than eight hundred miles from the sea border. A further natural advantage of the Congo worthy of mention is that, in the equatorial zone, amongst other plants the oil palm yields a continuous supply of fruit all through the year.

Elephants appear to be as numerous as ever, notwithstanding all the hunting to which they have for many years been subjected, and the statistics show no decrease in the output of ivory.

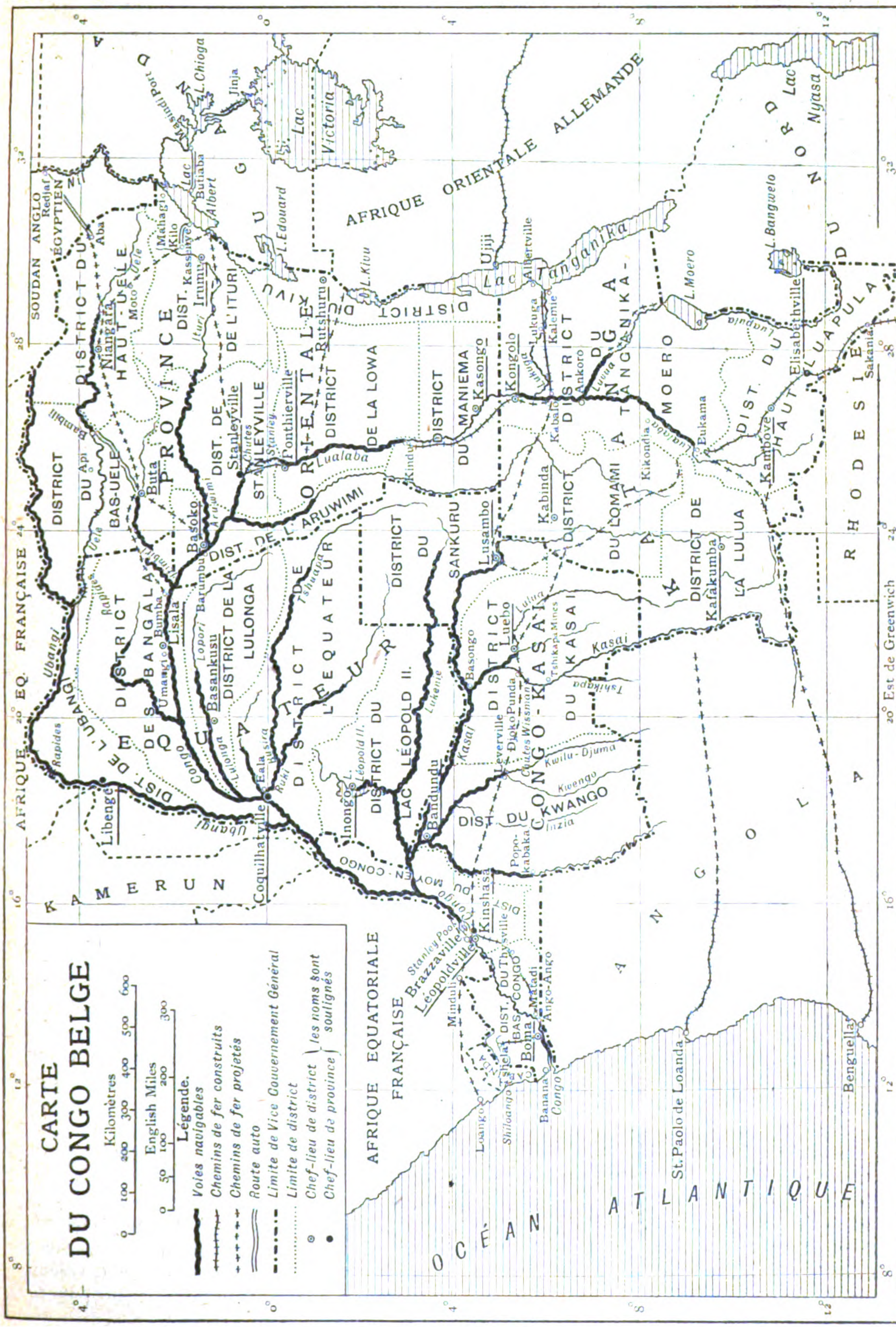
For the big-game hunter the Congo affords a most attractive and varied field.

Beeswax, perhaps less plentiful than in other colonies, is offered for sale on the native markets, notably in the Upper Kasai and Upper Lulua regions.

Large quantities of African silk (anaphe nests) are reported in the central and north-eastern districts.

Of all the potentialities of the Congo I should regard as most valuable its possibilities for agricultural development.

It is, I believe, by the production of agricultural commodities more than in any other direction, however important, that this Colony will ultimately be called upon to contribute to the well-being of the world.


CARTE
DU CONGO BELGE
Kilomètres
0 100 200 300 400 500 600
English Miles
0 50 100 200 300
Légende.
Voies navigables
Chemins de fer construits
Chemins de fer projetés
Route auto
Limite de Vice Gouvernement Général
Limite de district
Chef-lieu de district
Chef-lieu de province
les noms sont soulignés
AFRIQUE EQUATORIALE FRANÇAISE
AFRIQUE EQ. FRANÇAISE
KAMERUN
OCÉAN ATLANTIQUE
SOUDAN ANGLO ÉGYPTIEN
AFRIQUE ORIENTALE ALLEMANDE
OUGANDA
RHODESIE DU NORD
ANGOLA
PROVINCE ORIENTALE
KATANGA
CONGO-KASAI
Lac Victoria
Lac Albert
L. Edouard
L. Kivu
Lac Tanganika
L. Moero
L. Bangweolo
Lac Nyasa
Léopoldville
Brazzaville
Kinshasa
Matadi
Boma
Banana
Stanleyville
Coquilhatville
Lisala
Buta
Basoko
Kasongo
Kongolo
Albertville
Ujiji
Elisabethville
Sakania
Lusambo
Luebo
Kabinda
Kafakumba
Bandundu
Inongo
Libenge
St. Paolo de Loanda
Benguella
Loango
20° Est de Greenwich
Emery Walker Ltd. sc.

Every kind of tropical or semi-tropical produce will prosper in the Congo, which is richly endowed with the two essential factors —heat and moisture.

Looking from east to west, we first find the hot and rather insalubrious coastal region less than eighty miles wide. Then, crossing the range of Crystal Mountains over heights of 1,500 ft. and more, we reach the Stanley Pool (660 ft.). Beyond this point a fan-shaped plateau rises gradually southward and eastward, with an increasingly temperate climate. The altitude of the southern country ranges from 800 ft. to 5,000 ft. Snow-covered peaks of over 18,000 ft. are comprised in the eastern crest.

In the equatorial zone the rainfall (60 in. to 80 in.) is evenly distributed all through the year, and the temperature shows but slight variations. Seasons become more accentuated as we get farther from the equator. In Upper Katanga, for instance, the rainy season in 1915 lasted seven months (seven to twenty-nine days of rain per month), and the dry season five months (four to seven days of rain per month), the total rainfall amounting to 52 in., and the temperature varied from 38·8° F. (July minimum) to 92·8° F. (November maximum).

The soil is by no means uniformly fertile. Whilst there are many tracks of rich loam, notably in the volcanic regions west of the Great Lakes, sandy soils are predominant. Considerable areas have been impoverished by the primitive methods of cultivation practised for generations by the natives; and even in forest land the top soil is frequently only 20 in. deep.

In view of these circumstances misgivings have found utterance in respect of the agricultural possibilities of the country. But the lightness of the soil renders it easily workable — and is there any chemical deficiency which human science and industry cannot overcome?

None should be less dismayed by difficulties of this kind than the people of Flanders, who have carried their cultivations to within a few yards of the sea.

And does not the fact that many of the most valuable plants and trees are indigenous and thrive luxuriantly in their natural state in itself suffice to dispel all doubts as to the response they will give to the care of the planter? True, there is a good deal of poor land, but before the necessity can arise to turn this to account, millions of acres which require little or very little improvement will be found available for native and European enterprise, far in excess of what we could ever hope to see fallowed or planted in the near future.

Into this mass of natural wealth Providence has thrown an incomparable system of navigable highways—the mighty Congo River and its tributaries.

The majority of these streams, of comparatively recent formation, are intersected by rapids in their higher reaches, and the mountainous girdle of the Congo basin traversing the main river in its last stretch causes those fateful breaks which, until the last half century, shut off Central Africa from the outside world.

Need I point out that the rapids, together with a multitude of mountain torrents, constitute inestimable reserves of motive power, and that between the broken sections lie over 9,000 miles of navigable water?

All the natural wealth of the country would be of no avail without human energy to turn it to account.

The native population of the Colony may be put down at fifteen millions (estimates vary from twelve to eighteen millions). The census operations have not yet extended to the more remote areas, and even in other parts they are hampered by a well-founded suspicion that registration entails Government supervision. Who could blame the native for prefer ing that the administration should remain in ignorance of his existence as a possible taxpayer, and should continue to be unable to trace his movements and the whereabouts of his wives and children?

As a consequence of recent legislative measures (Royal Decree of November 16th, 1916) a definite register will probably be available a couple of years hence.

It has often been asserted that the territories which to-day form the Belgian Congo are less populated than when they first came under European rule. This opinion appears to be generally based on the fact that certain areas, which at one time were found to be well inhabited, are to-day almost deserted. It should, however, be borne in mind that many Central African tribes were, until recently, and to some extent are yet (*e.g.* in the southern parts of the Kwango and Kasai districts), habitually nomadic; that their exhausting agricultural methods entailed in particular the abandonment of the most extensively cultivated tracts of land; that, moreover, disease, as well as a desire to avoid

the white man, have frequently caused the native to withdraw from the main thoroughfares into the interior.

So much is certain: European rule has freed the aborigines of the Congo from the Arab slave raids and from inter-tribal warfare. Poison-ordeals, cannibalism, and other causes of violent death have been practically stamped out; the slave traffic in the interior will soon be extinct; hemp-smoking and other vices are severely repressed, and polygamy is being gradually reduced. All of these circumstances are obviously or presumptively conducive to an increase of population.

On the other hand, the rapid spread of sleeping-sickness and venereal diseases has caused terrible havoc; in some regions porterage and requisitions have been obtained at the cost of many lives; and it appears to be a deplorable but inevitable fact, also observed amongst other primitive races, that the fresh conditions of life created by the contact, or even by the mere presence of the white man, frequently produce a state of nervous tension which burdens the death-roll and decreases the birth-rate.

On balance, there is reason to assume that the unfavourable elements have been so far predominant, but that a turn of the tide has now been reached. The ravages of sleeping-sickness are becoming less severe, thanks largely to the indefatigable efforts of medical officers and missionaries, and to administrative measures in which the native communities have been called upon to co-operate. Mechanical means of transport are replacing porterage, of which, moreover, the hardships have been very much lessened. The natives are becoming gradually accustomed to contact with the European; and better conditions of food, housing and clothing, together with more provident and industrious habits, are bound to improve the physique and the power of resistance of new generations.

We may, therefore, in the near future, confidently expect a steady increase of the native population.

At fifteen millions, its average density works out at about 39 acres per head. Allowance must, of course, be made for waterways, swamps, and other tracts which cannot be brought under cultivation, and for such areas of comparatively small extent which a e only suited for pasturing purposes. Yet it appears manifest that the amount of forest and agricultural land available, to say nothing of the mineral resources of the country, remains enormously in excess of what the native population could possibly develop without the assistance of European organisation, science and equipment.

As already mentioned, the climatic conditions of the Colony vary widely according to the altitude of the different regions. Certain parts, notably the marvellous country west of Lake Albert and of Lake Edward, may be fairly compared with the Riviera. The Upper Katanga and Upper Kasai can properly be described as a white man's country; and there is, so to speak, no portion of the Congo in which the European could not reside for a considerable number of consecutive years. Precautionary habits and sanitary improvements will gradually eliminate those malarial diseases which constitute the principal, and I may say the only serious, danger which threatens the European settler. More comfortable housing and a greater variety of fresh diet will, moreover, increase his power of resistance, and as the white population increases in numbers he will find better opportunities for the education of his children, and the stimulus of social intercourse will replace the depressing effects of isolation.

At the last complete census (1912) the white residents numbered 5,465, of which 3,307 (60·5 per cent.) were Belgians and 505 (9·25 per cent.) British. I am sorry I am unable to give a more recent return. A certain decrease in the figure mentioned would probably be shown to-day; since the war a number of officials and others have joined the Belgian and British colours, principally in East Africa, and the citizens of enemy countries and representatives of enemy trading concerns have left the country. On the other hand, the number of European children is increasing; in 1915 there were ninety-six births. Exclusive of the Kivu district and of the officers and men on active service, the white population amounted to 5,289 on January 1st, 1915.

There is a growing influx of Arab and Hindu traders and craftsmen from the Sudan and from Uganda. In my opinion this should be welcomed: the adequate development of the Colony requires that the energies of the aboriginal population should be lea ened by the influence of more advanced races, and I believe that white emigration alone cannot fulfil this end.

From an economic point of view the aborigines are of unequal value. Ethnically they comprise such different types as the pygmies of the Aruwimi forests, and the long-legged plain-dwellers of the Upper Uele. There are tribes which can be specifically described as hunters, fishermen, pastors, and farmers. Some have

attained a considerable proficiency in the arts of weaving and pottery, and in iron and copper work; others show hardly any traces of even the most rudimentary civilisation. If vice and disease have brought certain races to a deplorable state of degeneration, the majority are muscular and healthy, or will speedily become so when they are taught to increase their supplies of vegetable and animal food and enabled to add to their diet a sufficiency of salt.

There is abundant proof that a very large section of the Congo natives show remarkable aptitude for learning the handicrafts of the white man. Some are already rendering valuable services as mechanics, engine-drivers, clerks, interpreters, typists, compositors, and telegraph operators. In the recent campaigns the native troops, drawn from various regions, have almost invariably shown the highest discipline and valour.

Although with few exceptions these peoples are peaceable and tractable, yet European enterprise in dealing with them finds itself frequently hampered by difficulties arising from their domestic organisation and the modesty of their wants.

European industrial and agricultural undertakings necessitate the regular employment of trained and more or less skilled workmen. The use of female labour for tasks which require physical strength is abhorrent to the civilised mind.

Now, generally speaking, the Congo native has from time immemorial been accustomed to throw on his women folk the burden of heavy work other than clearing, and he has a strong abhorrence to disciplined exercise for any protracted time. Moreover, where, as is the case almost in every part of the Congo, it has been the habit of each family or group of families to cultivate severally all produce required for the sustenance of its members, the labourer engaged in European employ will naturally feel a strong desire to leave his employer in order to take part in the selection and clearing of the patch on which the family crop is to be grown.

It has been contended that it should be one of the duties of the State towards the aborigines of a new country to avoid the creation of a salaried class. But economic progress would hardly be conceivable without specialisation, and a body of wage-earners will call forth a body of prosperous farmers.

As regards the difficulties arising from the small needs of the native, we must consider that in the less accessible parts of the Colony his desire for imported goods is practically limited to a few yards of cloth and a few bags of salt for personal use or for the purchase of wives. The necessity of obtaining a small amount of cash to meet the demands of the tax-collector is often his only additional inducement to seek temporary employment, or to offer for sale a modicum of produce, fish or live stock. This would appear to justify the paradox that with such primitive people a rise of wage or price would tend to decrease the supply.

However, emulation and education are rapidly creating fresh needs, which, stimulated by the traders' tempting offers, afford new openings for trade and a larger supply of steady labour.

Thus will these invaluable reserves of human energy gradually develop their productive power.

It is, I am convinced, to the best interests of the aborigines, as well as of humanity generally, that the dormant wealth of the Congo should be turned to account. For this the capital and methods of European enterprise are as essential as the co-operation of the natives. I therefore feel strongly that, although the aborigines may indisputably have a first claim to the resources of their ancestral land, nevertheless part of these resources should be placed at the disposal of the white man in order to attract, secure, and remunerate his ventures. Without this an abundance of land, forests, and minerals would remain unexploited at least for an indefinite number of years.

But, however much the outer world may have a right to share in the products of the Congo in fair exchange for goods supplied and capital invested—Belgium being, perhaps, allowed a privileged title to such returns as a reward for the special services she is rendering to her Colony—I think I may say that the Belgian Government regard it as their fundamental duty to administer the Congo for the benefit of the Congo—*i.e.* for the prosperity of its inhabitants, amongst whom the natives constitute the enormous majority.

After this, I fear, rather superficial survey of the natural gifts of the Colony, let us rapidly go over what has been done to develop its latent resources and summarise the results so far achieved.

The authority of the State is to-day so well established that the trader and even the tax-collector can safely travel unarmed and unescorted almost anywhere throughout the Colony. During this war the natives have given most gratifying proof of their loyalty to King Albert

and of their attachment to Belgian rule. The townships and minor State posts number 487.

The present administrative organisation is based on that which the genius of King Leopold conceived and brought into being with astounding celerity. But it has been remodelled in many respects.

Thus, for instance, with a view to expedite the occupation and opening up of the country, the late King, Sovereign of the Congo Free State, whose personal means were insufficient to cover the requisite expenditure, in some instances granted administrative powers to private companies. But the combination of commercial interests and executive powers in the same hands is fraught with dangers to which the Belgian Government, as the Colonial Minister on a recent occasion has publicly reasserted, are resolved never again to expose the peoples placed under their care. The fundamental law ("Colonial Charter") of the Colony, which came into force when Belgium took over the sovereignty of the Free State (November 15th, 1908), expressly precludes all delegation of executive authority to private individuals or corporations. It stipulates, moreover, that none (whether native or non-native) shall be compelled to work on behalf or for the benefit of private interests.

By a Royal Decree, signed on the eve of the war (July 28th, 1914), the territory of the Colony is divided into four provinces—viz. the Congo-Kasai, Equator, Oriental, and Katanga Provinces, of which the chief cities are respectively Kinshasa, Coquilhatville, Stanleyville, and Elisabethville.

The executive head of each province is a Vice-Governor, assisted by a complete and distinct staff of officials.

The Vice-Governors are subordinate to the Governor-General, whose present residence is Boma, and who is, in the Colony, the representative of the King and supreme head of the whole civil and military administration.

It should be mentioned that the final organisation of the two first-named Vice-Governments has been delayed in consequence of the war.

The unit of administration is the district, in which the District Commissioner is the sole authority and has at his disposal a number of financial, technical, medical, agricultural and military officers. The district is divided into territories, the territorial administrators acting under the direct control of the District Commissioner. The districts, of which there are twenty-two, comprised in the provinces already referred to, have all been organised in their present limits from 1912 to 1915.

In the delimitation of these territories the native tribal divisions have, so far as possible, been taken into account. The aboriginal population is being grouped into chiefdoms and sub-chiefdoms, the greatest care being taken to establish the authority of those individuals who, according to native custom, are entitled thereto. More than 4,000 chiefdoms have already been organised. These communities are called upon to co-operate in administrative measures directly beneficial to themselves—such as road-making and protective clearing against sleeping-sickness—within the limits of their own chiefdom. Their chiefs exercise such traditional powers as civilisation can tolerate, and act as intermediaries between their subjects and the administration.

At the end of 1914 a force of 1,800 native policemen and nearly 18,000 native soldiers, commanded by European officers and non-commissioned officers, was employed or held in readiness for the maintenance of public peace in the Colony. Recent events have demonstrated the value of these effectives, but that they were greatly in excess of the requirements for which they were intended; although a large proportion of this force has been on active service "abroad," its absence has not given rise or led to local unrest.

The judicial staff of the Congo, comprising seventy-nine judges and public prosecutors, all professional legal men, may seem abnormally large as compared with that of other Colonies. But public opinion in Belgium is not prepared to admit that an administrative officer should be allowed more powers than a police magistrate. The absolute independence which the judicial body enjoys in the Congo with regard to the executive constitutes, I believe, a valuable, if perhaps an exaggerated, safeguard for the white as well as for the native population.

The whole of the country is open to missionary effort of every denomination. There is complete freedom of creed and teaching. The number of mission stations already exceeds 160, in addition to which several hundred native assistants are spreading the principles of Christianity and the rudiments of all European learning. It is estimated that about half a million children are at present receiving religious instruction. Three special schools have been established for chiefs' sons, and one for half-caste children, of whom there are about 600 in the Congo. One Belgian mission, that of the

Scheut Fathers, has to it credit no less than fifty schools and twenty orphanages. The State is initiating, or is subsidising, several schools for the training of clerks and artisans, notably at Boma, Buta, Lusambo, Stanleyville, and Elisabethville. In other localities private enterprise is encouraging similar teaching, and it may be confidently hoped that within a few years the supply of trained native employees and craftsmen will be sufficient to meet the growing local demand. Besides the benefits accruing to the native community by the advancement of some of its members, the services of educated black men of local origin will appreciably reduce the working expenses of European enterprise in the Congo.

To mention other measures which are destined to further relations between the white and native elements, markets under Government supervision have been organised in the majority of the territories. The officials responsible have strict orders to prevent fraud and illegality, but not otherwise to intervene in the transactions effected.

At Elisabethville, a labour exchange, on the South African model, is working satisfactorily.

Thanks largely to the munificence of King Albert and his Queen, there are now ten hospitals in the Colony, besides a number of lazarets. Provision is made for 101 State doctors; but military necessities have for the time being reduced this staff considerably below its full complement. There are a few private practitioners, and five of the principal companies have engaged doctors for their employees and labourers.

The medical facilities thus provided would be superabundant if the white residents alone were to be considered. But it would be quite inadequate to the needs of the native population were it not for the indefatigable assistance of the missionaries, of whom some are qualified doctors.

The natives, even in the more remote regions, are gradually overcoming their diffidence towards unaccustomed methods of treatment, and beginning to recognise the utility of the steps taken to arrest the ravages of sleeping sickness.

To complete these remarks, I must mention three legislative measures which contribute to the safety and health of the population.

In accordance with the stipulations of the Brussels Conference (1890), stringent limitations have been placed on the import of, and traffic in, fire-arms. The consequent difficulties which the natives sometimes encounter in the protection of their crops against elephants and other wild animals must be regarded as a lesser evil as compared with the dangers which might arise if they were in possession of modern weapons.

The terrible vice of hemp-smoking has, to a large extent, been stamped out, thanks to a systematic destruction of the weed.

Finally, the liquor traffic is subjected to restrictions, of which the principles were laid down at the same Brussels Conference.

The legislation on the subject, which until recently did not apply to the coastal region and has been several times revised, to-day applies to the whole of the Colony, and is as follows:—

"No native may import, or have in his possession, intoxicating liquors of more than 8 degrees proof, nor may a white man sell or give such liquors to the native.

"The white man can obtain an 'alcohol ticket' for 3 litres (two-thirds of a gallon) per month of liquor exceeding 22 degrees; but is limited to this allowance."

By this policy the Congo Administration has deprived itself of what might potentially constitute a principal source of revenue.

But although the consumption of highly fermented palm wine by natives to some extent nullifies the beneficial effects of this "sacrifice," the Belgian Administration has shown its firm intention to establish further limitations rather than to abandon this policy, the initiation of which is to the credit of the Congo Free State.

The dangers, hardships and discomforts which early pioneers had to encounter have everywhere been greatly lessened, and in many parts have disappeared. The Congo is no longer the land of peril and renunciation which attracted only the boldest and most self-denying, nor is it the last resort of social failures.

Throughout the Colony European commodities are easily obtainable; there is an ample supply of imported and locally-produced food. Comfortable and sanitary houses are rapidly replacing the old mud hutments and corrugated iron buildings. In the main centres of the Lower Congo and Katanga modern hotels have sprung up. Railways and steamers render travelling between the principal townships commodious. To-day the death-rate from natural causes amongst the European population is well below 2 per cent. per annum; a protracted stay in the Congo entails little more than ordinary risks. and a few months' visit may be regarded as a pleasure trip even for a white lady.

Considerable efforts have been made by the Government with a view to a better knowledge of the country's resources.

Scientific missions have been sent out for almost every branch of research. In this connection, it is to be hoped that the valuable and irreplaceable collections of the Congo Museum at Tervueren, near Brussels, will be found intact at the liberation of that city, although the loss of documents which were left at the offices of the Ministry of Colonies is to be feared.

Needless to say, all information of scientific or commercial interest in the possession of the Government is at the free disposal of the public.

Agricultural research has been thoroughly organised within the last few years. The Botanical Gardens at Eala cover 500 acres. Several mycological, bacteriological, entomological and agrilogi al laboratories have been established, and there are at present twenty experimental stations and farms. At one of the latter, at Api (Uele), the possibility of taming the African elephant for domestic use is being patiently tested, and not without success.

I should perhaps mention that these experimental cultivations and farms are undertaken without any view to profit, *i.e.* solely for the guidance and benefit of native and European enterprise. Seeds and live stock can be obtained, in many cases gratis, from these stations, to which are attached agricultural experts whose task it is to visit the surrounding district and give advice and assistance to natives and settlers.

The system of plantations for revenue purposes which the Free State Government had established on a large scale is now definitely abandoned. As soon as an agricultural experiment can be regarded as conclusive, and the station is no longer required for the distribution of seeds or the raising of breeding stock, the land and buildings are put up for sale or given over to the natives. Eight of the twenty stations referred to are at the present moment for sale, while new experiments are being prepared in other regions.

But the most effective way of opening up the country for investigation and trade is, of course, by development of the means of communication.

On the abnormally small ocean front which has been allotted to the Congo in consequence of the historical claims of Portugal, there is only one port, that of Banana, at the mouth of the river. But ocean-going vessels ascend the huge stream up to Matadi, close to where—100 miles from its mouth—its course is interrupted by the first rapids. The swiftness of the current in the "Devil's Cauldron," just below the latter harbour, renders it difficult of access to steamers of less than twelve knots. An additional port will shortly be established at Ango-Ango, three miles lower down.

A little more than half-way up this stretch is the port of Boma, which serves as an outlet for the produce of the Mayumbe district.

In 1914, 312,344 tons were cleared at Banana; 265,226 tons at Boma, and 133,509 tons at Matadi.

The regular services established between these ports and Europe are that of the Company Belge Maritime du Congo, which in normal times goes to Antwerp and at present to Hull, and that of the French Chargeurs Réunis, going normally to Havre and at present to Bordeaux. Amongst the occasional callers I should name the Elder Dempster, Empreza Nacional, and Bromport liners.

As regards the gigantic system of waterways in the Upper Congo, these rivers are, generally speaking, comparatively shallow in consequence of their unusual breadth. (The main river towards the summit of its curve attains a width of twenty miles.) In consequence the steamers supplying the Upper Congo do not as a rule exceed a 3 ft. draught, and are usually of the stern-wheel or tunnel-screw type. Interesting experiments are in progress with motor-propelled "gliders" as a means of rapid communication.

Sandbanks and snags render navigation dangerous at night and often cause considerable delay. An active hydrographic survey service has drawn up charts and is marking out the most favourable channels and carrying out dredging operations with a view to remedying these inconveniences.

Wood is the fuel generally employed, and State or native wooding-stations are established at regular intervals along the main course. The use of petroleum would mean a saving of time and of cargo space. These considerations had, shortly before the war, induced a company to lay down a pipe-line between Matadi and Stanley Pool, but the abnormal conditions of the oil market have delayed a fair comparison of the respective merits of the two modes of fuelling.

There are at present on the Upper Congo about one hundred steamers, of which forty-five are State-owned or State-controlled, in addition to a number of barges and whale-boats. The aggregate carrying capacity of this river fleet amounts to about 9,000 tons.

No licen e is required to put ships on the Congo or on any of its tributaries, nor for the

establishment of goods or passenger services on these rivers. Navigation on the Congo is entirely free.

The former Government had placed private shipping at a disadvantage by decreeing a very heavy tax on steamers, based on their assumed consumption, for fuelling purposes, of wood from domanial forests. One of the first acts of the Belgian Administration was to reduce this tax, which to-day stands at a quite nominal figure.

Thanks to the State-owned fleet, not only are freights in the Upper Congo maintained at a very low level, but the small trader is afforded the same facilities which more powerful firms and their associated companies derive from the private ownership of steamers.

Amongst the interior ports by far the most important is that of Leopoldville-Kinshasa, at the gateway of the Upper Congo. The bustling activity of this twin township—rapidly growing into one—of its extensive wharves, store-houses and shipyards, cannot be witnessed without leaving behind a convincing impression of the Colony's vitality.

The three comparatively short sections on which the course of the main river is interrupted by rapids have been supplemented by railroads.

At the very foundation of the Congo Free State the urgent necessity of a railway to connect the Upper Congo with the ocean was recognised as essential to the success of King Leopold's venture. Without this connection nothing but the most valuable produce could be exported, and that only by the costly and painful means of human carriers over a mountainous country. Animal transport had been tested and had proved a failure.

Begun in 1893 the Congo Railway was completed, despite many difficulties, within six years. For its inception and achievement the Colony owes a debt of gratitude to the inspiring energy of the late General Thys. Well built and well equipped, this narrow-gauge line (27.8 in.) of 250 miles—which has cost, including accessory buildings, about three and a half millions sterling—has so far sufficed to deal with the traffic of the Upper Congo and of the adjoining districts of French Equatorial Africa. But the time is close at hand when, without extensive constructional improvements, it will be quite inadequate to convey towards the ocean the growing flow of heavy produce.

Practical means of transport being established between the seaports and the waterways above the first group of rapids, a magnificent reach of the main river, twelve hundred miles in length, as well as the principal tributaries, were rendered accessible to commerce.

But in order that the whole of the great semi-circular high road which Nature has traced through this country might be laid open to traffic by steamship or rail, the Stanley Falls and a further stretch of rapids remain to be negotiated. The railway by which these obstacles have been overcome was completed in 1900, and comprises two sections—viz., Stanleyville-Ponthierville (83 miles) and Kindu-Kongolo (222 miles). Stern-wheelers of 250 tons ply on the intermediate water and up to the terminus of the navigable Congo, Bukama, 2,200 miles from the mouth of the river.

The natural outlet of the Colony towards the Atlantic having been thus improved, attention was turned to the means of connecting this channel of communication with the Indian Ocean and the South African railway system.

Whilst the administration of German East Africa was actively pushing forward the line from Dar-es-Salam *viâ* Tabora to Ujiji-Kigoma with a view to commercial and, perhaps, other penetration into Northern Katanga, a railway (169 miles) was placed under construction on the Belgian side of Lake Tanganyika, starting from Kabalo and reaching the lake at Kalemie, somewhat south of the township of Albertville. This line, which was completed towards the end of 1915, has rendered conspicuous service during the present war. It was designed mainly to open up a very promising coal and tin country where successful mining operations are already in progress.

With a view to avoid transhipment to Kabalo and Kongolo, a railway connection will, no doubt, in the near future be established alongside the navigable river between these two points, which are hardly 40 miles apart.

It is now possible to travel from the Pacific to the Atlantic right across Central Africa from Dar-es-Salam *viâ* Stanleyville to Banana within the space of a month.

Elisabethville, the capital of the Katanga province, still had to be linked up with Boma, the capital of the Colony, and the discovery of the stupendous copper deposits north of the first-named locality warranted an additional more rapid and, perhaps, more convenient communication with the ocean.

In 1909, after five years of preliminary survey and as soon as all doubt was dispelled as to the extension of the Rhodesian line to the Congo frontier, the construction of a railway between

the British terminus and Bukama was definitely decided upon. The work has been carried on from both sides simultaneously, and, were it not for the present shortage of rail plant, would by this time have been completed. As it is, nothing is required to connect the two finished sections (50 miles from Bukama and 370 miles from Sakania on the Rhodesian frontier) but the laying down of sleepers and rails on a stretch of 50 miles, and an overland route between the Lower Congo and Cape Town will be thus established.

I have only one other railway to mention —viz., the narrow-gauge (24 in.) line of the Mayumbe. This leads from Boma due north through prosperous cocoa plantations and plentiful palm groves to Tshela on the Lubudi, an affluent of the Shiloango (85 miles). The line will shortly be extended to this river, with which it will then compete for the export of agricultural produce from a comparatively small but thickly-populated region.

The aggregate length of fully-equipped public railways to-day stands at 1,229 miles, of which more than two-thirds (851 miles) have been constructed in the last eight years—*i.e.* since Belgium took over the administration of the Congo.

This, undoubtedly, is a record to be proud of. But a great deal remains to be achieved.

The north-eastern districts and at the opposite corner of the Colony, the southern regions of the Kwango and Kasai districts, in which there is little navigable water, must be provided with railroads.

More than ten years have elapsed since the question was first mooted of a railway to connect the Congo with the Nile.

On May 3rd, 1906, the British Government and the Sovereign of the Congo Free State entered into an agreement which provided for a railway between the Congo frontier and the latter river. The construction and working of this line were to be conceded to an Anglo-Belgian company, on terms to be agreed upon between the Sudanese and Congo Governments, and in order to secure the capital expenditure required the Egyptian Government undertook to guarantee 3 per cent. interest on a sum not exceeding £800,000.

This agreement has not so far been carried out, and possibly never will be. Besides, its practical interest is, to a large extent, subordinate to the construction of the much longer section from the Anglo-Belgian frontier to the Congo River.

A considerable traffic, passing mainly through Aba, is rapidly developing between the Sudan and the north-eastern districts of the Colony; Greek and Arab traders are bringing goods into the wholesale stores of Khartoum and taking out considerable quantities of ivory and rubber. Moreover, now that the great mineral wealth and climatic advantages of these regions have been realised, the importance of opening up this country has become more tangible.

Two almost parallel but by no means competitive lines are in contemplation. The first track would start from a point either near Bunba or near Basoko and extend *viâ* Buta through a rich palm country and the Moto goldfields to Aba. It is to be noted that access to Buta is at present afforded by the Itimbiri River, which, however, is impracticable to steamers during five months of the year.

The other line has already been surveyed. It would connect Stanleyville and Mahagi (Lake Albert) *viâ* Iruma with a branch to the Kilo and eventually to the Moto gold mines.

In the present conditions, Kilo and the surrounding country up to about 150 miles west of Lake Albert, can be more conveniently approached from Mombasa than from Boma. The Mombasa route comprises rail and water transport up to Masindi Port on Lake Chioga, motor transport to Butiaba on Lake Albert, a steamer service across the lake to Kassenye, from whence a short but very steep road leads up to Kilo. The facilities between Masindi and Kilo will no doubt be improved in the near future. But when once the contemplated connection with Stanleyville is established a keen competition will in all probability arise between the two routes. I venture to say that this prospect should by no means delay the completion of either; the development of this part of the Congo, without taking into account the local trade, will I feel certain procure abundant traffic both for the eastern and the western routes.

At the Berlin Conference, Sir Edward Malet, the British Plenipotentiary, asked Stanley if, in his opinion, the railway from Vivi (Matadi) to Stanley Pool would be sufficient as a commercial outlet for the commerce of the Congo basin, and Stanley replied "Certainly not."

The soundness of this prediction is becoming every day more manifest. It would be childish and futile to attempt, as the wish has sometimes been expressed, to direct the entire traffic of the Colony towards the main river, and the Stanley Pool and Matadi railway.

To-day the bulk of the Upper Katanga output

is carried southward and shipped from Beira. A few months hence the alternate route of Bukama-Stanleyville-Matadi will be open. A third—shorter and perhaps cheaper—channel to the ocean, the Benguella railway, will probably be available at a not far distant date. A fourth track has already been fully surveyed which, crossing the tributaries of the Kasai River at approximately their navigable termini, would connect the Katanga railway with the Lower Congo line.

Should the latter scheme mature, as we may reasonably expect it will, not only would a means of rapid communication be established between the Atlantic ports, including the capital of the Colony, and Elisabethville, but one of the best-endowed and most densely inhabited regions of the Congo would be rendered accessible to adequate development.

A branch line would probably extend to Lusambo, the head port of the Kasai River. According to another scheme, this locality would be connected by a railway *viâ* Kabolo to Lake Tanganyika.

Finally, it should be mentioned that the French contemplate tapping the resources of the Congo basin by means of a line from the Atlantic to Stanley Pool (Brazzaville), of which a finished section, from the Pool to the copper-mines of Minduli is already feeding the Lower Congo railway. The Portuguese also are pushing forward their Northern Angola railway from S. Paolo de Loanda towards the Upper Kasai.

Each of these routes will serve a distinctive purpose and none of them will be superfluous. The wealth of the Congo cannot find too many outlets.

I shall not enlarge on the controversy as to the respective merits of railways and waterways. Some day it may be found expedient to improve the less navigable river stretches, including those alongside which railroads have been laid down. It has been estimated that even the rapids of the Lower Congo can be overcome at the comparatively low cost of £4,000,000. May I be permitted to submit that the effect of parallel lines of railway and navigable water is not to diminish but rather to increase each other's utility and traffic?

The presence of fly renders animal traction impracticable in the majority of districts, and the luxuriant vegetation and heavy rainfall make the upkeep even of metalled roads an arduous task.

Yet without a good network of roads the country could only partially be opened up for administration and commerce. The winding native paths cannot suffice.

Although a very large amount of work is urgently required to be accomplished in this direction, the aggregate length of State-built roads already exceeds 5,600 miles. This figure includes a motor road on which a motor transport service is established between Buta and Bambili (154 miles), connecting the navigable Itimbiri and the Uele River.

A company working the diamond mines of Tshipaka (Southern Kasai) has constructed a motor road alongside the Wissman Falls.

The following are the principal caravan routes generally provided with porterage services and rest houses: from Niangara to Aba towards the Nile; from Kilo to Moto; from a point above Ponthierville to Lake Kivu; from Lusambo to Ankoro (above Kabalo), and to Bukama; from Lake Moero to Elisabethville and towards Ankoro.

Speedy and, above all, cheap means of transport are to the Congo a matter of paramount importance for the development of its resources, the prosperity of its inhabitants, its commercial intercourse with the adjacent colonies, and its sea-borne trade.

Although superior to probably any other country in the abundance and variety of its natural gifts, its promise is impaired by one disadvantage—distance.

In order that its output of agricultural and mineral produce may compete in the markets of the world with that of other lands less favoured in all respects except as regards distance, excessive cost of transport should not impede either the introduction of plant and machinery up to the remotest regions where dormant wealth awaits to be aroused, or the circulation and outflow of the riches yielded by its soil.

The present Government of the Colony have given ample proof of their readiness to sacrifice immediate revenue for the indirect and ultimate benefits accruing from enhanced prosperity, and I think I may confidently say that, subject to a fair and generous regard for vested rights, they would not hesitate to set aside such private interests as might be found to stand in the way of progress.

To make a brief reference to other means of communication in the Colony. There are at present fifty-one post offices dotted over the country; nearly 2,000 miles of telegraphic lines (Boma - Stanley Pool - Coquilhatville; Kabalo-

Kalenie; Kambove-Sakania), and fifteen wireless stations (Banana, Boma, Kinshasa, Coquilhatville Basankusu, Umangi-Lisala, Basoka, Stanleyville, Kindu, Kongolo, Lukuga, Kinkondje, Elisabethville, Lusambo and Kilo). It will be noticed that ten of these stations have been erected at nearly regular intervals along the curve of the main river. They form an uninterrupted chain of communication between Boma and Elisabethville.

The Congo is connected at Banana with the "Eastern" cable system. Reuter's messages are received regularly in the principal localities, and posted up within a few hours from their issue in Europe. Besides official bulletins and missionary periodicals, the press is represented in the Colony by two local papers.

As for banking facilities, the Congo possesses only one—but very active—financial institution, viz., the Banque du Congo Belge, a Government-controlled bank of issue.

As an indication of the activity of the Colony, I may mention that the amount of remittances —passing through the bank—from the Congo to the neighbouring colonies or Europe, and *vice versâ*, at present approximates £4,000,000 per annum.

In this connection, the fact that since the beginning of 1915 the Congo exchange has not exceeded the rate of 25.50 francs per one pound sterling, may perhaps be regarded as worthy of notice. In the present circumstances, the Congo finds its principal markets, both for sale and for purchase, in the United Kingdom and British Possessions. Thanks to the comparatively high value of its currency—a corollary of its favourable trade balance—the Congo has been able to obtain goods without the additional charge of a premium in respect of exchange. An inflation of prices and wages has been thereby avoided, whilst the stability of the exchange has relieved the Congo trade and its suppliers of what might have been a very disturbing risk.

Reviewing the Colony's equipment, some of the essential features of its economic legislation can hardly be passed over in silence.

In accordance with a theory embodied in the legislation of most countries, the very first Ordinance (July 1st, 1885) of Sir Francis De Winton, the first Governor of the Congo, proclaimed that all unoccupied land would be regarded as the property of the Crown.

It has been argued that there is no vacant land in the Congo; that, according to native custom, practically the whole territory is divided up into contiguous areas held in communal ownership. But this view appears to be founded on a confusion between the political and the private rights as established by native tradition. Although a right is frequently claimed by tribes, or groups of families, to prohibit a stranger to the community from establishing himself, or from hunting, within certain boundaries unless he be granted permission to do so and agree to pay a tribute, corroborative evidence from all parts of the Congo goes to prove that the natives do not consider that they are entitled to an exclusive right, either communal or individual, except in respect of the land they have cleared, the cultivations they have established, and the trees they have planted or improved.

In practice, whatever may be its legal merits, a reasonable application of the principle which has been laid down in the Congo should not differ materially from that derived from the alternative theory which would vest the original ownership of all land in the natives, but would give the Government, the trustee for the native, power to dispose of the land in the best interest of the latter.

The manner in which the Free State Administration made use of the Crown land thus defined has given rise to vehement criticism. Before the establishment of European rule, the natives of the Upper Congo had left the exportable produce of the Upper Congo, notably rubber and gum copal, practically untouched. The soil bearing such produce, not being turned to any account, constituted vacant land within the meaning of the law, and consequently fell to the Crown. For the two distinct purposes of obtaining revenue and, by the offer of a strong inducement, of overcoming the reluctance of commercial enterprise to enter the Upper Congo, the Free State Government conceded to private companies the use, within huge areas, of all domanial land, and consequently an exclusive right to the principal exportable products therein.

The natives being taxed in kind, or for the estimated amount of labour required to collect a certain amount of produce from Crown lands, the exportable supplies thus obtained were included in the receipts of the beneficiary companies.

As a result of this policy, the country was to some extent opened up and a good deal of promiscuous planting was carried out in accordance with the terms of the concessions. But lack of competition, coupled with the pressure

which was brought to bear on the native tax-payer, permitted abundant profits without effecting either an industrious improvement of the land or an adequate remuneration for the natives' exertions. The Belgian Government have cancelled this system. Subject to the rights of third parties, the natives to-day enjoy the free disposal of the natural products of all land belonging to the State.

All the concessions referred to, with the exception of three regarding which negotiations were pending at the outbreak of the war, have been rescinded. But the Government still uphold their right to dispose of State land in whatever manner they may consider best calculated to benefit the interests for which they are responsible.

The law (Decree of June 3rd, 1906) defining the native rights of occupation has been found rather obscure and unworkable, and is at present under revision.

But it is the spirit in which a legislative system is carried out, rather than the words in which it is framed, that really signifies. The soil of the domanial land, in the same way as the natural products thereof, have been placed at the free disposal of the native communities. No hindrance is laid in the way of their planting or cultivating as much land as they please, or of their disposing of their crops as they think fit. Whenever land is granted to non-natives, ample reserves are marked out for the neighbouring native villages. If a native desires to acquire a right of individual ownership with regard to a plot of land, this wish is readily acceded to, subject to no other stipulation than that, after a time, he must show a moderate amount of improvements as a condition of the maintenance of his tenure, and that he is precluded from leasing or selling the land to non-natives during a certain period, after which the lease or sale is subject to no restriction whatever. This is the only case in which a non-native can obtain possession of native land without the sanction of the Government, a provision which has been enacted with a view to protect the native communities from despoiling themselves of their reserves.

Grants of land are given to non-natives on very liberal terms. Land for agricultural purposes can be purchased at about 1*s.* 7*d.* per acre, or leased at about 1*d.* per acre per annum. The price of a plot of about 2½ acres for a factory outside a township is £40. Within the principal townships well situated allotments are, however, rapidly appreciating in value.

The transfer of land is subject to a uniform tax of £1 only.

The grantee is required to carry out a certain amount of building, planting, cultivation, or other development. In more important cases he is liable to be called upon to prove that he disposes of a sufficiency of initial capital to enable him, with a reasonable prospect of success, to undertake the working of the land he applies for, and a minimum wage and eight-hour day are stipulated in favour of labour in his employ.

In short, the policy of the Government is to apportion the soil of the Colony in the manner in which it may be best turned to account, reserving first to the natives such land as they are utilising or may, in a not too far distant future, hope to develop, and offering the remainder to European enterprise.

The law of the Congo, as in most, if not all, Continental legislation, attributes to the Crown the ownership of the sub-soil, whoever be the owner of the surface.

In the Katanga Province, a two-year prospecting licence can be obtained for £4. The working of minerals discovered is subject to a royalty of 1 per cent. of the value of the output, except in the case of precious metals and diamonds, in which case it is 5 per cent. ; and 33 per cent. of the net profits go to the Treasury.

In all probability this system will be extended to the other provinces. A previous administration gave one large company exclusive prospecting rights over the greater part of the Colony outside Katanga. These rights, of which diligent and successful use has been made, have already partially lapsed, and will expire in the course of the coming year.

The goldfields of Kilo and Moto, which have been mentioned several times, are at present worked by the State. A good deal might perhaps be said in favour of breaking up this area into private "claims." But, whilst the country is hardly ripe to receive a gold rush, the output in these mines affords an opportune item of revenue, and their working entails no competition with private enterprise. All things considered, I believe that the present method of developing this valuable asset is, in the general interest of the Colony, the most appropriate for the time being.

As stipulated in the Berlin Act, the Congo is a country of absolute free trade.

There is no differential treatment in favour or to the disadvantage of any nation or individual with regard to either shipping facilities

or the export and import of goods, nor is there any monopoly in commercial matters.

Hawking is subject to the payment of an annual tax of £8 to £20; but neither a householder nor a native requires a licence to trade.

Except in respect of spirits, import duties are limited to 10 per cent. ad valorem. Seeds and fertilisers enter free; industrial and agricultural plant and machinery pay 3 per cent.

The 10 per cent. limit to which the Congo is restricted by an agreement entered into at the Brussels Conference (1890) may be considered unreasonably low for luxuries such as, for instance, high-class tobacco.

Ivory, gum copal, and rubber are liable to an export duty. The last-named produce is, however, not dutiable when the market price in Europe stands below 1*s.* 10*d.* per lb. for vine rubber, or 1*s.* 1*d.* per lb. for grass rubber. Plantation rubber goes out free. Export duties placed on other produce by the Free State Government have been repealed.

Direct taxation is established on a very moderate scale. There is, as yet, no income tax.

As to the natives' contribution towards the cost of administering the Colony, the former system of taxation in kind and assessment per tribe or village has been entirely abandoned. Besides the risk of an arbitrary estimation of the produce tendered in payment, it exposed the weaker members of the native communities to unfair pressure on the part of their chiefs.

The Government is authorised to impose an annual tax of 1*s.* 7*d.* to £1 per adult male according to the economic situation of the various districts. In practice, the maximum rate has been 9*s.* 6*d.*, the minimum 2*s.* 4*d.* Females are not assessed, but the male taxpayer is liable to an additional tax of 1*s.* 7*d.* to 4*s.* 9*d.* for every wife but one, with a limit in certain regions of £10 to whatever number he may have carried his matrimonial acquisitiveness.

For the financial year 1916 the yield of these native taxes amounted to a little over £400,000. A small figure with regard to the multitude of possible tax-payers, but a large one if we consider that this taxation is very leniently applied, and that the use of coin has only been disseminated in the Upper Congo within the last few years.

It may be worth mentioning in this connection that, in order that the natives shall be better protected against unfair dealings by a more definite knowledge of the relative value of the commodities purchased or sold, a law prohibiting barter between the native and non-native has recently been enacted.

The educational value of a moderate tax in cash is indisputable; in remote districts it frequently constitutes the initial inducement for the native to approach the trader or employer of labour with an offer of produce or service, and having devoted part of his first earnings to the purchase of European commodities the native acquires new needs and more industrious habits.

To conclude this long enumeration, I must refer to the part taken by private enterprise in the building up of the present plan of the Colony.

The aggregate capital of Congo Joint Stock Corporations approximates £29,000,000 sterling, and there are about a thousand factories of which, of course, a large proportion are owned, not by companies, but by individual traders.

But the capital which private enterprise has invested in improvements constitutes, I should say, a smaller asset than the ability and energy of the men who "at home" or "out there" are devoting their exertions to the development of the Colony. The best guarantee for its growing prosperity and participation in the commerce of the world which the Congo possesses lies in the steadily increasing number of its factories, settlers and hawkers, and of business men, who take an interest in its ventures, and of manufacturers and merchants who are studying and endeavouring to supply its special requirements.

If I may venture to single out two names typical of the co-operation of Belgian and other capital in the Congo, I should mention M. Gean Jadot, the far-sighted and vigorous Governor of the Société Générale de Belgique, the moving spirit of several of the principal and most valuable enterprises in the Colony, to whom notably is very largely due the extraordinarily rapid progress of Upper Katanga; and Sir William Lever, who is undertaking the development on scientific lines of some of the oil-palm forests forming part of the dormant resources of the Congo, and who by his methods and by his achievements is establishing a precedent no less beneficial to the Congo native than are, for the European working-classes, the great examples which he has set at Port Sunlight and elsewhere.

This—necessarily very incomplete—description of the present organisation and plant of the Congo will have failed to give a fair impression

of the actual position if it has not clearly manifested two facts—namely, that considerable endeavours have been made to open up and to bring the natural gifts of the country into bearing, and that nearly the whole of this work has been either initiated or completed within the last eight years. We must further bear in mind that, during more than one-third of this short period, the commercial and administrative development of the Colony has to some extent been hampered by the abnormal conditions arising from the great struggle in Europe, and by the campaigns into which the Congo has itself been obliged to enter.

In the light of these considerations, the following returns should be regarded as being merely the first fruits of the present equipment. The figures given are those most recently available. The £ sterling is taken as an equivalent of 25.25 francs.

The exports (special trade) for the year 1915 were valued at £2,850,000, this being the highest figure of an almost continuous progression, viz. :—

	£
1887	325,000
1890	433,000
1895	1,426,000
1905	2,098,000
1910	2,638,300

Any comparison of these amounts must take into account the exceptionally high price of ivory in 1905, and of rubber in 1910.

Quantities, however, afford a more definite indication than values. Here are some items out of a list of over 150 :—

	1913 (last pre-war year).	1916 (first half-year only).
Rubber	7,998,000 lb.	2,311,300 lb.
Ivory	5,524 cwts.	2,727 cwts.
Gum copal	4,697 M. tons.	4,080 M. tons.
Palm kernels	7,205 "	9,280 "
Palm oil	1,974 "	1,588 "
Rice	3½ "	582½ "

As regards minerals, the following tables give the output of the principal mining centres :—

Year.	Copper (Katanga). M. tons.	Diamonds (Kasai). Carats.	Gold (Kilo and Moto). Ozs.
1913	7,400	15,000	43,600
1914	10,700	39,000	55,000 (approximate)
1915	14,200	50,000	82,800
1916	22,200	60,000 (approximate)	95,200

The gratifying progress which these figures indicate only foreshadows the magnitude of the future.

In Upper Katanga, the Union Minière, a Belgian enterprise of which a British company holds about 40 per cent. of the capital, is diligently extending and improving its powerful installations; and the annual output of this undertaking alone is expected to amount to 50,000 tons of copper by 1920, and 100,000 by 1925.

The first shipments of tin are on their way to Europe.

The working of the Kasai diamond deposits has only just started, and the opening of other areas has been postponed until after the war.

This also holds true for the ascertained goldfields in various districts, and for the coal mines of Northern Katanga.

Amongst the European plantations, the Mayumbe cocoa firms were practically the only agricultural venture which had been successfully attempted before 1908. They are affording an increasing yield of excellent produce.

The experimental station at Barumbu (Aruwimi district) has demonstrated that there are as good or better possibilities for cocoa in the Upper Congo, and in the future this cultivation lies doubtless mainly in the central districts of the Colony.

Sugar, coffee, tea, tobacco, sisal-hemp, pineapples, bananas—to mention but a few examples—are bound to retain the attention of the European planter. It is from the Congo that the "coffea robusta" was introduced into the Dutch Indies, where it is used to the exclusion of almost every other variety. Sugar-cane is grown in the equatorial regions in every native village, and the local consumption would, I believe, suffice in itself to warrant systematic planting and the establishment of a sugar factory. The coconut will flourish as far inland as Stanleyville.

Congo rubber—vine and grass—the standard of which is being maintained by means of Government inspection, still holds its own against plantation rubber, and in view of its specific qualities will in all probability continue to do so. There is, however, no reason why plantations should not, with the same success as in any other part of the world, be carried on concurrently with the working of the wild product. Experts generally agree that Hevea (Para) would for this purpose be preferable to the indigenous Funtumia (Ireh).

The forest wealth remains almost untouched.

An enormous quantity of timber and pulp will some day be drawn from these inexhaustible reserves.

The manufacture of methylic alcohol is already arousing interest, and the more precious varieties of wood—which are admirably suited for panelling and veneering, neglected so far except for local use and a few occasional shipments—will probably commence to be worked in the immediate future.

The systematic extraction and export of piassava, raphia, and other fibres, of which there is an unlimited supply, should prove a most attractive proposition.

As yet, however, the fruit of the oil-palm is the only forest product, other than rubber, which, to any appreciable extent, has been exploited.

The Huileries de Congo Belge, an associated company of Lever Bros., Ltd., founded in 1911 with a capital of £1,200,000, is applying the spirit of organisation, which the African native lacks, to the clearing and improvement of extensive palm areas in the Bangala, Aruwimi and Kwango districts. Four mills, with an aggregate capacity of over 30,000 tons of fruit per annum, are already working, and others are under construction. This bold enterprise, of which the success is already manifest, cannot fail to call forth similar ventures in other regions, where huge tracts of palm foreets are still lying waste.

However, in many parts of the Colony the natives have, in a desultory manner, from time immemorial been gathering palm fruit and palm wine, from the abundance of trees disseminated by Nature; and in a number of instances they have established a small plantation close to their village. But, except in the Mayumbe, only a trifling fraction of the palm wealth of the country commensurate to the local consumption has been thus turned to account.

The gigantic oil and kernel production of the British West African Possessions conclusively shows what can be produced by the unaided efforts of the natives. Yet I should say that, where sufficient fruit is available to feed a mill, it will be found to the general interest that the wasteful and toilsome native methods should be superseded by the methods of European industry.

On the other hand, the working of small palm groves, of which there are a multitude in the Congo, may best be undertaken by the native as a farm industry; and now that exceptionally high prices have stimulated the trade in the Upper Congo, we shall certainly, and in a very short time, see an enormous progression in the native output.

It may be disputed whether the native can compete with the European for certain cultivations, such as cocoa. For others there can be no doubt that native farming will stand unrivalled. This, I believe, will be the case with the majority of low-priced produce wherever labour is abundant and is not engaged on more remunerative work.

Notwithstanding the natural facilities which the country affords, a very large part of the population is underfed. The increased production and better distribution of certain foodstuffs must be regarded as one of the most important improvements brought about in the last few years; nevertheless, much remains to be done in this direction.

To give an illustration. Until quite recently rice was being imported at great expense, and consequently in small quantities, into the Upper Congo. In 1916 the region of Stanleyville alone produced over 5,000 tons, and it is estimated that by 1918 the total rice crop will—after allowing for local requirements—leave an exportable surplus of over 15,000 tons.

A similar future awaits cassava, maize, ground-nuts, sesame, castor and other oil seeds.

Although conclusive experiments have only been made in the course of the last few years, I am convinced that cotton will soon become a staple of the Congo. In the Maniema district the test may be regarded as decisive: not only has the grade obtained been highly satisfactory, but the natives have shown remarkable eagerness in adopting the new cultivation. Henceforth, during the harvest season, weekly markets will be established, the State guaranteeing a minimum price. This system is being extended to other regions and to other produce.

The Colony is only just beginning to reap what the authorities and private initiative have sown. Whilst I fully realise that disappointments and setbacks are inherent in every human enterprise, I am confident that the Congo is now steadily going ahead, and with surprising speed, towards an undreamt-of prosperity. An authoritative estimate made shortly before the war, calculated the probable value of exports for the year 1924 at £10,000,000. I am inclined to believe that the actual figure will be nearly double that amount.

A corresponding increase in imports may be expected. Imports (special trade) had reached £2,805,000 in 1913, as compared with £824,000

in 1903 and £363,000 in 1893. This figure, to the extent of about 35 per cent., included plant and machinery. Ten years hence the consumption of imported goods by the natives alone, should, at the low average rate of 10s. per head, total over £7,000,000 per annum. In addition, there will be the upkeep and extension of public works to provide for, as well as an enhanced demand for commodities and technical appliances proportionate to the growing number of white settlers and traders.

So much for the prospective progress of the Colony within the next few years.

Looking further ahead, I hardly dare say what I picture to myself the country will be like, say, half a century hence when the Congo, the Heart of Africa, with a black population of 30,000,000 or more, and a white population of several millions, will—through many arteries, north, south, east and west—be pouring out gigantic supplies of raw material, and throbbing with the activities of some of the greatest industrial centres of the world.

The realisation of these prospects presupposes a sufficiency of two essentials—men and money.

Will enough capital be obtainable to open up the country further, extend its trade, develop its resources, increase the well-being of its inhabitants?

Will an adequate number of efficient men devote their energies to its administration and to its commerce?

There can only be one reply—the necessary money will be found, the right men will come forward.

The war has depleted the stocks of raw material in Europe, and it has popularised the use of certain manufactures, such as margarine, and thereby permanently increased the consumption of various products.

At no previous time were the potential supplies of the Congo more likely to attract attention or to stimulate commercial enterprise.

On the other hand, a considerable portion of the costly and powerful machinery which has been laid down for the production of munitions of war will be adapted and employed for industrial purposes. Moreover, territorial changes, fiscal measures, and reasons of sentiment will direct the trade of the now belligerent nations towards new channels. Can we assume that the Allies will omit to avail themselves of the openings afforded by the Congo?

In view of these circumstances, I am inclined to think that, after the conclusion of peace, plant and machinery will be procurable for public works on exceptionally favourable terms both as regards price and payment. Nor do I anticipate that the financing of remunerative undertakings will encounter any considerable difficulties.

As to administrative requirements, the more recent Congo Budgets have shown an excess of expenditure over revenue, which has caused some writers in England—and I regret to say, certain Belgians—to voice a doubt, loudly echoed in Germany, as to the ability of Belgium to bear the cost of governing her Colony.

Now, it is a fact that, since Belgium took over the Congo, annual expenditure has been materially in excess of revenue; but a closer examination of this deficit, put down at £640,000 in the estimates for 1917, will be found to be largely due to what may be called establishment expenses, and must be regarded as the inevitable consequences of the Government's determination to occupy, study, and organise the country with all possible celerity.

The soundness of this policy from a financial point of view, irrespective of all other considerations, is already proved by a considerable increase in the returns. During the next two or three years the work in hand will be completed. Provision has been made for the necessary means. After that, the fiscal yield on the outlay involved will, I am confident, suffice to ensure the maintenance and progress of the Colony. Obviously loans will have to be issued to cover the expenditure on railways and other public works. But besides the security which they may afford, the investor will find a safe guarantee in the general wealth of the country and in the character of its administration. I think the Belgian Government has fully proved the value of its bond; and, as the late Mr. J. P. Morgan said shortly before his death, "Character is more than collateral."

Before the war (returns of 1912) Belgium participated in the aggregate exports and imports of the Congo to the extent of about 80 per cent.; the British Empire for about 8 per cent. In the present conditions, when Belgium lies fettered, I should say that the Empire's share amounts to at least 75 per cent. A large proportion of this trade is, however, being carried on by Belgian firms, who are temporarily enjoying the hospitality which the Government and people of this country have so generously extended to my compatriots.

Liberated Belgium will find in her Colony an

invaluable source of supply to replenish her exhausted warehouses and revive her commerce, as well as a sure customer to refill her order book. She can continue to rely upon her leading banks, who have taken such a prominent part in the development of the Congo.

But commercial enterprise and the capital of all friendly nations will find an ample and remunerative field and outlet in the Belgian possession. Need I add that such co-operation will be most heartily welcomed?

Will Belgium find the right men to administer her Colony?

She is the youngest among colonising nations, and it takes time to form a class of experienced officials. Yet a number of her sons have long since gained repute in the Far East, in Persia, in South America; and the annals of the Congo already comprise a long list of names whose bearers have displayed the persistency and valour which recent events have shown to be inherent in their race.

With all due respect to the eminent representatives of the Crown in other Colonies, I venture to say that it will be difficult to find a more capable, active, and high-minded Administrator than the present Governor-General of the Congo, Monsieur Henry.

The average standard of men offering their services to the administration and commercial concerns of the Colony is incomparably higher than it was only a few years ago; and there is good reason to believe that many will be eager to go out who, but for the war, would have held back, notably amongst those who have become accustomed to the venturesome open-air life of the trenches or have learnt the fascination of Africa in the Congo campaigns; but also amongst those whose tragic memories or the ruin of their homes in Belgium will urge to seek a fresh career and livelihood in the new territories of their mother country.

When King Albert ascended the throne, seven years ago, he proclaimed his resolve to endow the Belgian Congo with a liberal and beneficent administration. Inspired by his example, and encouraged by his support, Monsieur Renkin, the first Minister of the Colonies of Belgium, has, up to this day, unfalteringly pursued—as he will, I hope, continue to do for many years to come—the fulfilment of this comprehensive programme. Belgium is proud to be entrusted with the development of the Congo, and she will joyfully further the efforts of whosoever may be willing to assist in the accomplishment of this great duty.

DISCUSSION.

The Chairman (Mr. Steel-Maitland, M.P.), in opening the discussion, said he thought the paper illustrated one or two points which had been more and more clearly revealed in recent years, and particularly by the course of the war. When the author exhibited on the screen the map showing the various means of communication throughout the Belgian Congo, in the heart of equatorial Africa, it flashed across his memory that only a few short years ago the whole of the map of the interior of Africa was a comparative blank. It was perhaps the most striking instance in existence of the way in which the whole life of the world, during recent years, had been affected by the fact that there were now no territories unappropriated and unenriched by human enterprise and industry. The last quarter of a century had seen the whole world parcelled out, so that what was done in one place, however remote, must quite inevitably have its reactions on the whole of civilisation. Another point of great interest, which up till quite recently had not been sufficiently realised, was the extraordinary fertility and powers of reproduction of natural products in the equatorial regions of the earth. Owing to the war, attention had been devoted in a way that had never been the case before, not only to rubber, but also to oils and fats. He had had very considerable reason to become intimately acquainted, not only with palm nuts from Nigeria and the trade in similar products, but the whole question of oils and fats. Before the war it was hardly realised that they formed such an important and indeed essential feature of trade and of our existence. Appreciation of the potential productivity of all the equatorial regions where there was a proper rainfall and a suitable climate for production, had come at the moment when the efficiency of white production and of machinery was increasing at a pace far exceeding anything that had happened before. The mechanical development of the nineteenth century had shown increasing powers of production, but throughout the last ten years the powers of machinery to utilise and convert natural products had progressed at an accelerated speed. All modern European countries, particularly England, had learned during the war that the capacity for production was previously much lower than it ought to have been per head of the population. If, after the war, the most was to be made of the possibilities of this country; if the standard of wages was to be sustained at anything like the figure it had reached during the war; and if, as all far-sighted men wished, the war with all its horrors should be succeeded in this country by industrial peace and not by industrial quarrels, there must be a vastly increased production in the country; and that would be brought about through the greater power of machinery, and a greater appreciation of the big tropical regions

of the earth as supplying the raw material which that machinery must use. There was an extraordinary necessity, from the point of view of human needs, for the development of the latent possibilities of those equatorial regions. He could not help expressing his own satisfaction that an ample proportion of the world's supply lay so largely in the hands of our brave Allies as well as of ourselves; and he was quite sure that all present extended their heartiest good wishes to Belgium in her task after the war—when she herself had been amply and fully rehabilitated—of further developing her great possessions in Central Africa. He trusted that work would be carried forward successfully by all the Allied nations. Since the British occupation of Togoland, a little more than two years ago, the area cultivated by the natives had increased by 30 per cent. under British rule as compared with German rule. The author had alluded to a question which must be at the back of the mind of every one who was in a position of responsibility with regard to tropical possessions, namely, the position and welfare of the native races over whom this country had a Protectorate. As M. Horn had said, the natives were entitled to a portion of the goods of the country which they produced, and Belgium and this country looked upon themselves as being primarily trustees for the benefit of the native races who lived in the Protectorates. From that point of view it was necessary, in the development of the country, to consider not only their tribal customs, but also their own civilisations, differing as they did from the most rudimentary to some that, as in Northern Nigeria, were quite far advanced. It was also necessary to consider respect for their own persons, so that what was by many thought to be an advance of civilisation for them, was really and truly a blessing in fact as well as in name. If that was their duty as trustees, he thought that after the war the problem that would have to be solved in this country was to harmonise our primary duty as trustees for the natives with a full development of the country for supplying the wants of modern needs in the more temperate regions. He suggested that the audience should carry away from the meeting, first of all an appreciation of the paper; secondly, an idea of the extraordinary fertility of the possessions in Central Africa; thirdly, the need that these possessions should be developed; and, fourthly, the great duty that lay upon them of harmonising that need with their primary duty as trustees toward the native races that lived in those parts.

M. RENKIN (Ministre des Colonies de Belgique) dit: Les vues exposées par M. Horn sont exactes. Le Congo est une colonie magnifique et le désir non dissimulé d'une puissance pour qui la force prime le droit de s'approprier la Colonie Belge est une preuve irrécusable de sa grande valeur. Je crois pouvoir affirmer aujourd'hui qu'autant et plus qu'avant la guerre, les Belges ont à cœur de conserver le Congo et de travailler à son développement futur. Je dis plus qu'avant la guerre parce que l'Union s'est faite aujourd'hui entre tous les Belges sur la question coloniale. Tous entendent conserver la Colonie. Les sentiments de sympathie exprimés à l'occasion de cette réunion causeront à tous les Belges la meilleure impression. L'occupation de leur territoire par l'ennemi a privé les Belges de toute leur activité intérieure. C'est dans la Colonie qu'ont pu s'affirmer l'énergie et la vitalité de la nation Belge dans le domaine de la guerre aussi bien que dans celui de la paix. Les chemins de fer ont été développés pendant la guerre, les exportations sont cinq fois plus importantes, ce mouvement ne fera que s'accentuer. La Belgique comprend qu'elle peut, grâce en partie à sa Colonie, prendre une large part dans le développement et la reconstruction de l'industrie en Europe, grâce à l'extension des cultures et à l'exploitation des matières premières que le Congo contient en abondance. Les nations colonisatrices ont un but supérieur qui est de protéger et d'élever les indigènes et, dans ce domaine également, la Belgique ne faillira pas à son devoir. Ce qu'elle envisage surtout en matière coloniale c'est l'extension de la civilisation. C'est pour la justice et la civilisation que la Belgique s'est sacrifiée au début de la guerre et c'est pour cela qu'elle continuera l'œuvre dont elle a accepté la responsabilité en Afrique.

SIR WILLIAM H. LEVER, Bt., said that, as one who had travelled with M. Horn through the Belgian Congo, he was of opinion that the author had not overstated the prospects of the country or the great work that the Belgian Government carried on there; in fact, he had understated and underestimated whenever he had ventured either to make a statement or a prophecy. Personally he wished the author had drawn the picture a little nearer those sanguine lines which he was sure in his heart of hearts he thought was correct. The Congo was offered by Stanley in succession to the United States, England, France, and Germany—but they all refused it. Belgium possessed a far-seeing King, who saw the immense possibilities of the country; he took an early train to Marseilles, met Stanley on his arrival there, and secured for his country what had been refused by the great nations of the world. It was right, therefore, that Belgium should enjoy the benefit of the foresight of its King. Whatever had been heard about the cruelties to the native races in the Belgian Congo had a German origin, and were substantially not correct. The cruelties imposed on the natives were part of the native chiefs'

form of government. There was no gaol and no imprisonment as in this country, and the punishment for theft and every other crime was mutilation; and the natives mutilated by the native chiefs formed the basis of the stock, panicky cry in England against the Belgian Government. At the same time he did not mean to say that no cruelties had been perpetrated on the Congo natives, and it could not be said either that cruelties had not been perpetrated on the natives in British Colonies, but they were grossly exaggerated, and were not correct as told to the public of this country. With regard to the attitude taken by this country to native races, whenever he went into English Colonies he always found an outcry against what was called "Exeter Hall." It was a curious fact that in the House of Commons the same people stamped, and stormed, and raved about the iniquity of dukes, who held their land for their own comfort and kudos and not for the service of their fellow men, and it was considered wise that statutes should be enacted to compel dukes to use their broad acres for the general benefit of the public. But the same men said in regard to a black man, who might or might not be a prince, that this country had no right to interfere with his land, and that he must use it or not use it as he liked; that there might be countless millions in Europe starving for oils and fats and for all the produce that generous Nature could pour forth under tropical suns and tropical showers, but the black man must not be interfered with. He did not consider that that was good government. There were good black men and bad black men, and good white men and bad white men; but he did not see why we should have a sentiment for a man because of his colour. Nevertheless, that was the case in British Colonies all over the world. In his opinion the world was meant for the use of the people who were at present living in it, and the man who could make use of the tools, whether the hammer, the chisel, or the broad acres, for the benefit of the general public had a right to them. The only title of every white man or black man was to make the best use of them for the public. He believed the black man could be spoiled as much by sentiment as by brutality, and he understood the latter better than the former. But neither of them need enter into the question of the government of the black man. The main thing was the education of the native, and the Belgian Government were showing the English the way in that respect. If the black boy was educated from an early age, great use could be made of him. It was absolutely necessary to remember that the country would never be developed unless the black men who lived in it were educated. White men were not necessary there. The black man could get on without the white man, as he always had done, but the black man was necessary to the white man. It was impossible for progress to be made in the tropics without the aid of the black man. If the black man disappeared, as he had in some parts, the whole place would become a desert. Having educated him, the next subject that must be dealt with was transportation, and that was being dealt with by the Belgian Government through the building of railways and the making of the rivers navigable. Boats must be put on the rivers, and produce carried for the smallest traders at equal rates obtained by the largest, so that all were placed on one level of equality in competition. That policy, in his opinion, would do more for the black man than sentiment. He must be educated, trained, and disciplined; but, above all, it was necessary to be firm with him and let him understand that the land that he might call his own or not had to be developed and exploited and made to produce the fruits of the soil. On those lines, which the Belgian Government were following with great ability, the tropics would yield their full and abundant harvest for the benefit of the white man in the temperate countries.

MAJOR E. H. M. LEGGETT, R.E., D.S.O., in moving a hearty vote of thanks to M. Horn for his paper, said the author had given a compendious account of the problem connected with the place which Africa held, and would hold in the future, in the economic life of the world. It might not be known to the majority present that when His Majesty King Albert visited the Belgian Congo as Prince Albert, to inquire into the supposed atrocities, which it was now known were persistently exaggerated and even invented by the Germans, he was accompanied by M. Renkin; and it was at that time that the lines of government and development described in the paper were laid down. They had been followed ever since, and had resulted in a marvellous development which was the subject of the respectful admiration of the people of this country. It was a blessing for the world that so large a part of Africa was in the hands of our enlightened friends and Allies the Belgians. Many people had not realised that perhaps of all the continents of the world Africa stood to gain most from the war, namely, that for all time the native races would be free from the play and counterplay of opposite schools of thought, action and government. Belgium, France and Great Britain were working on the lines of recognising, first of all, the trusteeship of the white for the black; secondly, the education of the native stage by stage, through the lines to which he was accustomed up to the higher forms of agriculture and mechanical and industrial development; and the German system of government, which was so diametrically opposite, had been eliminated from African soil. It was, therefore, not too much to say that millions of Africans yet unborn

would benefit from the present terrible war, to an extent that no other country outside of Europe could.

THE HON. RICHARD CLERE PARSONS, in seconding the motion, said the only security that the Belgian Congo could have against invasion, in the way its Mother Country had been invaded, was that the British Fleet should continue to occupy the seas of the world. He hoped the British Fleet would for ever rule the seas, so that peace throughout the world might be ensured.

The resolution of thanks having been carried unanimously, M. Horn briefly acknowledged the compliment; and Sir Frederic W. R. Fryer, K.C.S.I., having expressed the thanks of the Colonial Section Committee to Mr. Steel-Maitland for his kindness in taking the chair, the meeting terminated.

OBITUARY.

REGINALD LE NEVE FOSTER.—Mr. Reginald Le Neve Foster died at Torquay on February 11th. He was the fifth son of Peter Le Neve Foster, who was Secretary of the Society from 1853 till his death in 1879. The family has been connected with the Society almost from its foundation. Peter Le Neve Foster's father—also Peter Le Neve—joined the Society in 1807. His grandfather, Abraham Osorio, had become a member in 1800, and Abraham's father, Jacob Osorio, was also a member from 1766. Jacob's brother Abraham carries the record a little further back, because he joined the Society in 1761 —seven years after its foundation. Reginald Le Neve Foster became a member in 1880, and the family is still represented by his son Basil and by another grandson of Peter Le Neve Foster, Vivian, the son of Sir Clement Le Neve Foster.

He was born at Camberwell in 1846, and was educated at London, Brussels, Stuttgart, and Prague. For a short time he was associated with Price's Patent Candle Company, and afterwards he became a pupil of Dr. F. Crace Calvert. Eventually he joined Dr. Calvert, who was the first to manufacture pure carbolic acid in this country, and to apply it to disinfectant and therapeutic purposes. In 1857 Dr. Calvert established works in Manchester for the manufacture of carbolic acid, and these were considerably developed in 1865. Mr. Foster became connected with these works, and before his death he had completed fifty years' service as their manager.

He always took a very great interest in the affairs of the Society, and in July, 1914, he presented to the Society a sum of £100 for the purpose of founding a prize in commemoration of his father. The amount was afterwards increased by a further donation to £140, and the prize was first offered in 1915 for an essay on "Zinc, its Production and Industrial Applications." The offer produced a number of valuable essays, and the one to which the prize was awarded, by Mr. J. C. Moulden, was read as a paper before the Society in May, 1916.

GENERAL NOTES.

RUSSIAN EXHIBITION.—With reference to the note in the *Journal* of March 30th, it should be added that the Hon. Organiser of the Russian Exhibition, to be held at the Grafton Galleries in May next, is Lady Muriel Paget, and that all communications respecting the Exhibition should be addressed to 32, Victoria Street, S.W. (1)

COTTON IN UGANDA.—The area under cotton in Uganda in 1915–16 was 92,217 acres, as against 118,778 acres (the record figure) in the previous year. The decrease was due to the difficulty experienced in selling cotton for over six months in the period 1914–15, which tended to discourage growers and retarded seed distribution. Practically the whole crop, which is of a high standard American grade when marketed in clean condition, is ginned in the Protectorate. The bulk of it is sent to Great Britain, but a new market has been found in India, which bought over 9,000 cwt. in 1915–16. The erection of ginning factories in centres of production, according to the Report on the Trade, etc., of Uganda, recently issued by the Colonial Office (Annual Series, No. 914), is being continued. Exports of cotton seed amounted to 5,225 tons in 1915–16, as compared with 9,017 tons in 1914–15. The seed is also used as fuel for generating power in many of the ginning factories, and as it is a bulky and low-priced commodity, the quantity exported depends largely on the shipping charges.

FOREIGN TRADE OF JAPAN.—The great expansion of the foreign commerce of Japan during the period of the war is emphasised by the official returns now available for December and for the whole of last year. For 1916 the total value of imports was 756½ million yen, being an increase of 224 millions, while the exports for the same period amounted to 1,127½ million yen, being an increase of about 419 million yen. The actual excess of exports over imports for the year was 371 million yen as compared with 176 million yen for 1915, while the changed position which has taken place since the commencement of the war may be gathered from the fact that for the year 1914 there was actually an excess in the value of imports over exports of about 4½ million yen. Instead, therefore, of having an adverse balance against her as in the pre-war days, Japan has a large surplus balance the other way.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

NEXT WEEK.

WEDNESDAY, APRIL 18th, at 4.30 p.m. (Ordinary Meeting.) HORACE M. THORNTON, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance." SIR GEORGE THOMAS BEILBY, LL.D., F.R.S., Chairman of the Fuel Research Board, will preside.

THURSDAY, APRIL 19th, at 4.30 p.m. (Indian Section.) R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products." Owing to the absence of the author in India, the paper will be read by LAURENCE MERCER, C.I.E., late President, Imperial Forest Research Institute and College, Dehra Dun. SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., Member of the Viceroy's Council, 1910-15, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Tuesday, March 27th, 1917; The RIGHT HON. AUSTEN CHAMBERLAIN, M.P. (Secretary of State for India), in the chair.

THE CHAIRMAN, in opening the meeting, said that they were met in a good cause, and for excellent reasons, one or two of which he would venture to mention because they would be sufficient to justify his presence in the chair. In the first place the paper dealt with an Indian subject—one of vast consequence to India but also of great interest to the scientific world of this country. It contained something of the work which was being done in the field of medical research in India, and of the great opportunities for study and for progress which were open to those who would make that field their own But he had more personal reasons for attending. The paper was written by Sir Pardey Lukis, the Director-General of the Indian Medical Service. The Civil Medical Services of India had given of their best and given freely for service in the present war. Sir Pardey Lukis, for a short time in the interval between the resignation of one Director of the Army Medical Services and the arrival from Europe of his successor, held that post; and he was glad to have the opportunity, especially in view of all the criticism—some of it just and much of it unjust—which had fallen upon Indian medical administration, of publicly paying a tribute to the admirable work which was done by Sir Pardey Lukis in the few months during which he filled that position. The energy which he threw into it and the progress which he obtained were alike remarkable, and reflected the greatest credit upon him and upon the Service of which he was so distinguished a member. The last reason he had for attending was a personal one. The paper was written by Sir Pardey Lukis, but it would be read by Sir Havelock Charles, the President of the Medical Board at the India Office, and the Medical Adviser of the Secretary of State. He was indebted to Sir Havelock Charles for all the work he had done for him at the India Office. His task was often a difficult and a disagreeable one, but he discharged it with great impartiality and great ability; and he (the Chairman) was glad to be present to pay a personal tribute to him also.

The paper read was—

OPPORTUNITIES FOR ORIGINAL RESEARCH IN MEDICINE IN INDIA.

By SURGEON-GENERAL SIR C. PARDEY LUKIS, K.C.S.I., K.H.S., M.D., F.R.C.S.,

Director-General, Indian Medical Service, and President, Scientific Advisory Board, Indian Research Fund Association.

As members of an Empire so widely distributed as is ours over the four quarters of the globe, few of my audience are likely to be unconscious of the debt the Empire owes to

medical research; nevertheless, I am justified perhaps in assuming that many of you have no clear idea of the magnitude of that debt.

It is not my purpose to direct your attention to the striking advance made by medicine and surgery during the past twenty years in the civilised countries of the West; rather I would have you look farther afield to those vast British tropical and sub-tropical dominions beyond the seas and to the smaller outposts of the Empire—countries in which England has been called on to secure the welfare of hundreds of millions of fellow subjects, 90 per cent. of whom have only a rudimentary knowledge of sanitation and preventive medicine—countries which have death-rates unparalleled in more fortunately placed Britain, and where the inhabitants are decimated by diseases—largely of a preventable nature—from which Britain is happily free.

To such British possessions I would direct your attention for a moment, and ask you to consider with me what medical research has done there in the past, what it is doing now, and what it hopes to do in the future. More especially would I direct your attention to our great Indian Empire, which is that portion of our dominions about which I am best able to speak from personal experience. Has Britain risen to the occasion and been faithful to her great trust? It is no exaggeration to say that, practically speaking, the science of "tropical medicine" has been created within the last twenty years. I have no wish to decry the epoch-making discoveries made anterior to this period, such as Laveran's discovery of the malaria parasite in 1880; Koch's discovery of the cholera vibrio, both in Egypt and in India, in 1884–1885; Vandyk Carter's work in Bombay on the spirillum of relapsing fevers; Manson's observations in connection with filaria and mosquitoes in 1879–1883; and Kitasato's discovery of the plague bacillus in 1894. With the exception, however, of those mentioned above, workers in this huge and fascinating field were few and far between. In spite of the efforts of this band of pioneers, it was not until the close of the last century that the real importance of the subject began to be realised. In this connection, the efforts of Sir Patrick Manson to obtain for tropical medicine its due meed of recognition can hardly be rated too high. In 1898 Ronald Ross, then a member of the Indian Medical Service, working on lines that had been hypothecated by Manson, succeeded in demonstrating the life-history of the proteosoma parasite of birds, showing that a species of mosquito was instrumental in conveying from bird to bird the malaria-like proteosoma parasite, for which the mosquito acted as a host. Subsequently he observed an identically similar cycle in the development of the malaria parasite itself. The importance of these discoveries cannot be overestimated. New and important fields in research were opened up, to which were attracted numerous enthusiastic workers. About this time the country was flooded by the wave of Imperialism that the late Mr. Joseph Chamberlain did so much to foster. That great statesman was the first to recognise the importance of Britain's Overseas dominions, and to impress upon stay-at-home Britons the necessity for making healthy and contented the dwellers in these vast possessions. In this way research in tropical medicine received an impetus the effects of which are seen to this day. Tropical medicine had come into its own, and two schools of tropical medicine were established in England—one at Greenwich and the other at Liverpool.

[At this point Sir Havelock Charles said: Here, in the name of workers in tropical medicine, I desire to thank our Chairman for coming to-day. We all know the immense burthen of work on his shoulders. Yet, in spite of it all, in keeping with the spirit of his father's memory, he, to show his sympathy with those engaged on work for India and the Indians, makes time to preside at our meeting. This cannot fail to have a good influence, as showing we have a Secretary of State not unmindful of the benefits conferred on India by the Western system of medicine and the untiring labours of the medical profession in that country.]

India was not slow to appreciate the importance of the movement; but at the beginning of this century the attention of all research workers in that country was chiefly directed to the visitation of plague that had commenced six years previously, and which then showed every sign of involving the country in unparalleled misfortune. The difficulties, the mistakes, the failures that naturally attended the efforts to control a disease about the methods of the spread of which we were then in helpless ignorance demonstrated the urgent need for medical research; but at the same time they tended to distract attention from the problems presented by other diseases of almost equal importance to the country.

Towards the close of the last century, and in the early years of the present, the Indian Medical Service was fortunate enough to attract

a number of men with a bent for medical research, who came to India fired by enthusiasm and determined to take full advantage of the unique opportunities that India offers for original investigation and scientific discovery. The service owes a debt of gratitude to Sir Almroth Wright, then Professor of Pathology at the Army Medical College at Netley, who did so much to fan the flame of this enthusiasm in all those who were fortunate enough to receive instruction and inspiration at his hands. At that time the Indian Medical Service could not boast of any special research department, but the investigations carried out, often in the face of considerable difficulty and with but little or no official encouragement, by individual officers such as Semple, Glen Liston, Rogers, McCarrison, and Mackie did much towards the creation of the present Bacteriological Department. This department was designed originally with a view to staffing the newly-created research laboratories in Bombay, Kasauli, and Madras as well as the Pasteur Institute of India. In recent years the department has developed considerably, and it now consists of twenty-nine cadre appointments, the majority of the incumbents of which are employed in research work, and have no other official duties to distract their attention from the problems under consideration. In addition to these, a considerable number of additional appointments are, as a rule, available in connection with special investigations and inquiries. Appointments in the Bacteriological Department are not reserved entirely for members of the Indian Medical Service. They are open to independent medical men possessing the necessary qualifications for medical research, and at the present moment six independent practitioners, one European and five Indians, have been admitted. The European (Dr. Gibson) is Director of the King Institute, whilst Drs. Turkhud, Soparkar, and Goré are working at the Bombay Bacteriological Laboratory, Parel, and Drs. Korke and Iyengar at the Central Research Institute, Kasauli, where another Indian gentleman, Mr. Awati, is working at the bionomics and classification of the various species of house flies. At present we have in India three research laboratories, at Kasauli, Bombay, and Madras respectively, and Pasteur institutes at Kasauli, Coonoor, and Rangoon, whilst two others will be opened in the near future—one at Shillong, and the other in connection with the Bombay Bacteriological Laboratory at Parel. All these institutes and laboratories are specially designed to offer facilities for post-graduate work and medical research. We shall shortly, moreover, possess two schools of tropical medicine in India—one at Calcutta and the other at Bombay. That at Calcutta is practically completed, and will be opened under the directorship of Sir Leonard Rogers as soon as the cessation of hostilities enables us to furnish the necessary professorial and teaching staff. The one at Bombay, which is being erected in connection with the Bombay Bacteriological Laboratory at Parel, is also approaching completion, and will shortly be opened under the charge of Major Glen Liston, the director of the above-mentioned laboratory. The Government of Madras, moreover, has under consideration a scheme for founding, in connection with the Madras Medical College, a pathological institute with provision for post-graduate and research work. All these institutions will offer unrivalled facilities for the investigation of tropical diseases. It may be mentioned, moreover, that attached to the Central Research Institute at Kasauli is a Malaria Bureau, which, under the charge of Major Christophers, is doing work of the greatest value. This remarkable progress, most of which has been effected within the last five years, is striking evidence of the importance that the Government of India attaches to medical research. The enthusiasm displayed on all sides augurs well for the future, and, provided that India continues to attract men with a leaning towards the scientific and research sides of their profession, there is no limit to the possibilities of the future.

Perhaps the most important of the more recent developments in medical research has been the establishment of the Indian Research Fund Association, which was founded in 1911. Generously endowed by Government, practically the only limit to medical investigation since its establishment has been the difficulty of obtaining a sufficient number of scientific workers of a suitable stamp. The association publishes its own journal—the *Indian Journal of Medical Research*—which has almost completed the third year of its existence. A reference to its pages will, I believe, offer striking proof of the valuable work already performed by the association. Numerous subjects have been dealt with, notably malaria, cholera, dysentery, yellow fever, kala-azar, the cinchona derivatives, plague, tuberculosis, bacteriological standards for tropical water supplies, diabetes, goitre, and leprosy, not to mention the various entomological investigations. The war has, of course, seriously curtailed the activities of the

association for the time being, but in spite of this the achievements of the past four years in India form a noteworthy page in the history of medical research.

Though much has been done, we have scarcely touched the fringe of all that calls for investigation. It is, indeed, a fascinating and, in parts, an almost unexplored field that calls for the attention of the research worker, and the facilities and opportunities offered are unique. There is scarcely one of the communicable diseases of India which will not repay further research. In the case of plague we require more accurate information as regards the remarkable immunity of vast tracts in India, chiefly on the east and in Burma, where rice-cultivation is predominant, also as to the part played by grain and grain godowns in the spread of the disease, and the influence of late-infected villages in carrying over the disease from one plague season to another, thus constituting epidemic foci during the following year. Numerous bacteriological problems connected with leprosy require further study, and much work still remains to be done in connection with the isolation and cultivation of the lepra bacillus, whilst recent observations justify the belief that there are important therapeutic possibilities in connection with the hypodermic injections of Chaulmoogra oil and of the salts of gynocardic acid.

Kala-azar has still to yield its epidemiological secrets, especially as regards its mode of transmission and its identity or non-identity with the infantile kala-azar of the Mediterranean littoral.

Rabies, too, presents many important problems for consideration. The Pasteur treatment of this disease, so far as India is concerned, has been revolutionised during the past few years by Semple's discovery of the value of anti-rabic inoculation by means of a carbolised dead virus, whilst researches are now in progress which may possibly lead to further improvements in this method of treatment. The work of Acton and Knowles, moreover, on snake-bite, which was conducted at the Pasteur Institute, Kasauli, has thrown new light on the subject of the use of antivenine, and has demonstrated the lines upon which further research is necessary if treatment by antivenomous sera is to be thoroughly successful.

During the last two years it has been demonstrated that relapsing fever is much more common in India than was realised formerly, and investigations are urgently required into the conditions favouring its development and spread in certain regions. Mackie's observations have demonstrated that the body-louse is the carrier of the ordinary type of this disease, and those of Nicolle have proved that transmission is due to accidental crushing of the lice, the mere bite being innocuous. Many problems, however, still remain unsolved, and we cannot regard *P. vestimentorum* as the only carrier of spirillar fevers in India. For instance, Browse has described an outbreak of an abnormal type of relapsing fever in Quetta, which he considers to be transmitted by *Argas persicus*, and Jukes has reported typical cases of spirillar fever in the Darjeeling district which closely resemble the remittent fever of Vandyk Carter, but in which a careful examination of lice and bugs from the infected houses failed to demonstrate the presence of spirochætes in these insects.

Then, again, the fevers of short duration and uncertain origin which in some respects show such striking affinities with yellow fever, and which under various local names are universally prevalent, urgently call for investigation, especially as regards the carriers of the disease, about which the greatest confusion prevails—some incriminating *Phlebotomus papatacci*, others *Culex fatigans*, and others again *Stegomyia fasciata*. There is also the important question as to whether dengue, Calcutta fever, Gilgit fever, etc., are separate entities, or whether they are modifications of one and the same disease. An investigation into all these points had already been planned when the outbreak of hostilities rendered it necessary to postpone this till a more suitable occasion. In this connection I may mention another important problem, namely, the relationship of *Stegomyia scutellaris* to yellow fever. Is it or is it not a carrier, and is there anything in the suggestion that by driving out *Stegomyia fasciata* one may protect a given locality from infection ?

The dysenteries have still their unsolved problems, both from the etiological and the therapeutical standpoint; whilst every day we realise more fully the importance of further research before we can recommend to Government the undertaking of extended and expensive anti-malarial measures, especially such as involve the clearing of jungle and the utilisation of the silt of the large rivers. New light has been thrown on the subject of jungle clearing by the investigations of Strickland in Malaya, and in view of the conflicting opinions expressed by Bentley and Fry in Bengal, Marjoribanks in Bombay, and Kenrick in the Central Provinces, it is evident that further research in this direction is eminently desirable. It is also

necessary that careful investigations should be made into the problems presented by malaria in Lower Bengal, as distinguished from that of Upper India, to enable us to arrive at a definite conclusion as to whether or no the malarial endemicity of the Gangetic Delta can best be dealt with by attempts at drainage and jungle clearing or by irrigation and utilisation of the silt of the large rivers, as in Egypt. In this connection there is a growing feeling that the silting up of these large rivers, with consequent agricultural depression and physical deterioration of the inhabitants, is a very important factor in the causation of the disease. Investigation, too, is required into the factors which are responsible for the seeming paradox that, whereas in some parts of India rice fields are harmless, in others they are highly malarious. There is, moreover, the important question of the causation of blackwater fever and its relationship to malaria, in connection with which the suggestive papers on "*Acidosis*" by McGilchrist, and on the "Hæmolytic point" by Christophers and Iyengar, offer valuable suggestions for future work.

Then, too, the flies of India, both blood-sucking and non-blood-sucking, the sand flies, the hook worms, the filaria and guinea worms, the larvæ-destroying fish and other natural enemies of the mosquito, the flagellates of plants, and the various parasitic fungi offer ample scope for research to the entomologist, the helminthologist, the botanist, the biologist, and the mycologist, whilst the pathologist will find his labours amply repaid by careful investigation into the various forms of pernicious anæmia (especially that peculiar disease called "sukhi", which follows child-birth), as well as into osteomalacia, infantile hypertrophic cirrhosis of the liver, the so-called "scurvy rickets," and beri-beri. The last mentioned deserves special attention, both from the general point of view of a deficiency disease and as regards its relationship to "epidemic dropsy." Other problems of vital importance are those connected with the possible fixing of bacteriological standards of purity for potable waters (a subject in which Morison is doing such good work at Poona); the question as to what extent, in view of Greig's recent work, cholera can be regarded as merely a water-borne disease; the probable connection of goitre with fœcal contamination of the water-supply; the comparative value of the various cinchona alkaloids; the therapeutic use of intravenous injections of metallic antimony, and the soluble antimonial preparations in the treatment of kala-azar; the possibility of substituting for the more expensive emetine the cheaper alkaloids of opium, such as narcotine and papaverine, as remedies for amœbic dysentery; and the investigation of the properties of indigenous drugs. As regards the last point, I may mention that it is intended to found a Chair of Experimental Pharmacology in connection with the School of Tropical Medicine at Calcutta.

We are indeed far from the goal towards which we are tending, but the future is big with promise. The possibilities are limitless. When the importance of medical research is still more widely recognised, when we realise the debt which the medical profession owes to itself, to its country, and to the millions of our fellow subjects in the outlying parts of our Empire, then medical research workers in tropical and sub-tropical climes will attract to themselves recruits from the best intellect of the profession. When this happens, let us hope that the claims of India will not be overlooked, and that the unique advantages offered by the Indian Research Fund and the Bacteriological Department of the Indian Medical Service, with their numerous research institutes and laboratories, will be estimated at their proper value.

I am not referring to the deeds of medicine and surgery, carried on whether in the teaching hospitals, the civil hospitals scattered broadcast through the length and breadth of the land, or to the travelling dispensaries which bring aid to the ryot at his door in far out-of-the-way villages. Nor do I mention that hard-worked man, the civil surgeon, who to be an asset to Government should be a man of character and personality—for such alone will carry out those works of supererogation so essential and for which money does not pay. This is a class to which Government owes much and the people of India more, but a class too often forgotten when honours are distributed! For such work as these officers carry on, the best medical men that this country can send are required.

DISCUSSION.

THE CHAIRMAN (the Right Hon. Austen Chamberlain, M.P.), in opening the discussion, said he was not competent to discuss the details of the paper, but there were one or two broad considerations to which he desired to refer. Sir Havelock had been good enough to remind him that he had an hereditary interest in the spread of learning connected with tropical medicine. When his father first went to the Colonial Office, and considered one of the great

hemispheres into which the activities of a Colonial Secretary were divided, he quickly came to the conclusion that if this country was to do its duty by its tropical dependencies it was of the first importance that the health of the people who went to them should be improved. We had been for so long accustomed to send our best to India that he was not sure it had always been recognised, or that those who went to India recognised, how much still remained to be done in that country in the light of modern progress in science and medical research. He was convinced that nowhere in the Empire was there a larger field for research and for fruitful experiment, which might be a blessing, a safeguard, and a protection against needless sacrifices and heartbreaking sorrow, not only for the men of our own race and the families that sent them forth, but for the peoples of the country itself. He was struck at the India Office with the scale on which Indian life was measured—with the scale on which nature worked there. To many of those present, who for long years had been familiar with Indian conditions, that sense of the magnitude of the populations that were being dealt with had lost its novelty and had become a commonplace; but to one who, like himself, came fresh to the consideration of Indian problems, there was something appalling in the scale on which the ravages of nature worked amongst the hundreds of millions of the populations of India—plague, famine, snake-bite—things which were far distant from the people of this country, but which claimed their victims in India, not by tens nor by the score nor by hundreds, but by thousands and tens of thousands. Whether one looked at the problem in the light of the vast mass of humanity whose interests were at stake, or whether one looked at it in the light of the numberless problems which were still unsolved and which awaited the willing worker, India offered a splendid field for research and for the service of mankind. There was a consideration which was equally applicable to all who worked in India, whether they were Europeans or Indians, but he wished to say a few words about the share of the European in the task in question. This country had always sent of its best to India. Nothing but the sending of its best would justify the position which we held and maintained; but never was it more necessary than at present that it should be the best that should go. This country had brought Western learning within the reach of Indians; it had invited them to share its pleasures and its mysteries, its temptations and its dangers. They had readily responded to the facilities which were put before them; they were taking an ever-increasing interest in those things, and would play an ever larger part in the development and the progress of their own country. That was the object of British government; that was one of the great reasons for which it existed. Just in proportion as we were successful, more was demanded of those who represented this country among them. Just in proportion as Indians qualified to take their part, the Englishman would only discharge the great responsibilities which rested upon him if he was of the very best that England could send, and nothing short of the best was good enough for India. He therefore made such appeal as he could to the leaders of the medical profession in this country to make themselves aware of the openings which service in India afforded, whether in the immediate practice of the profession, or in that interesting and most important research work with which the paper dealt. He appealed to the leaders of the profession and the teachers and heads of the great medical schools to make themselves acquainted with the opportunities that were offered by India, then to spread that knowledge among their pupils, and not to grudge to India some of the best pupils that were produced. It was necessary to recruit in this country. He was very conscious that, as a result of the war and the sacrifices made therein by the medical profession, there would be a greater call for doctors and a less choice in the years that immediately followed than there had been in the past. But if all had to go short, let all make some sacrifices. No one should think that all the best ought to remain at home, and that the second best were good enough to represent this country overseas. It was only with the goodwill of the heads of the profession that men could be recruited who would maintain the honour and the reputation of the profession in India and elsewhere throughout the Empire. It was of the first consequence, as a matter of Imperial policy, that that should be done; and it was partly to plead with the heads of the profession that they should at least encourage those who were inclined to take up a career in India, and give a proportion of their best students for that purpose, that he was present at the meeting that afternoon.

Sir Patrick Manson, G.C.M.G., M.D., F.R.S., desired to take the opportunity of congratulating the Society on having secured Mr. Chamberlain as the Chairman of the meeting. On such an occasion, as an advocate of tropical medicine, he was the right man in the right place, because the mantle of a distinguished parent had fallen on a distinguished son. He hoped that the Chairman would be as successful as his father in forwarding the interests of tropical medicine. There could be no question, considering the extent of the Indian Empire, its enormous population and variety of races, and its variety of climate, that it must include also an enormous variety of disease. That was due not only to the aggregations of huge masses of humanity, but to the insanitary conditions that existed, and

to the enormous variety of animals with which dignified man had so much in common. That was a community of interest which man was not very proud of talking about, but it was none the less true. Man was a beast, and the sooner he recognised that fact the better. It was a stab at his pride, but it was an encouragement to modesty. In the past he had had considerable experience in the study of tropical diseases in China, and he was there struck very forcibly with the latent capacity of the Chinese for studies of that kind. The capacity of the Japanese in that direction had already been proved, and there was a latent capacity in the Indian which would in due course be developed. With that object in view, he had strongly urged the encouragement of attempts being made by Indians at original investigations into tropical diseases. He thought that rewards of some sort—he did not say pecuniary rewards—should be offered sufficient to induce them to take up such a line of study. He suggested that there should be a multiplication of students in the medical colleges in India, and that special attention should be given by the teachers to qualify those men to act as original investigators. The Indian's brain was more subtle than that of an Englishman; his imagination was more active, while his manipulative skill was enormously greater than an Englishman's. When he was in practice in China he got a Chinaman who, after a little training, was able to do all his microscopic work, and he had not the slightest doubt that if the same thing was carried out in India it would be equally successful. He was exceedingly glad to hear that the Indian Government was encouraging research. When he was a young fellow, there was a rumour at home to the effect that any man who wanted to pursue medical studies in India would be more or less shelved—he would be looked upon as a troublesome man and not acceptable to the administration. Those bad days were over, and if proper appreciation of some sort were held out to European medical men in India, and especially to the native medical men, enormous strides would be made in the study of tropical medicine. He hoped that India would always possess as sympathetic a Secretary of State as the present one; if he was like his father in that respect it would be impossible to wish for more, because his experience of the late Mr. Joseph Chamberlain was that he was always willing to grant money for the carrying out of original research.

Sir Malcolm Morris, K.C.V.O., F.R.C.S.E., after congratulating Sir Pardey Lukis on his admirable paper, said that on his return home from a trip to India in 1914, he wrote an article in the *Times* on the subject dealt with in the paper. As a result he received an enormous amount of correspondence, some abusive and some the opposite, and it at once showed him that he had hit a point of the very gravest possible importance. He urged in that article, as strongly as he could write, that tropical schools of medicine should be established at Bombay and at Calcutta. He had been connected with the tropical school at the Albert Docks, and had lectured to students upon certain tropical diseases which he had never seen. He had also lectured on some which had come from the tropics to this country, therefore differing in many respects from what they were in their own country. After visiting India and seeing the very remarkable work that was carried on there, he came to the conclusion that the proper place for men to learn about tropical diseases was on the spot. It was well that there should be schools in England, like that at the Albert Docks and at Liverpool, to train men in the art of observation, so that when they went to the tropics they might be able to utilise the knowledge they had gained at home when carrying out the research. Sir Havelock Charles was right in his statement that investigators were born and not made, but there was something more than merely being born; there was something in being cultivated. A man had to be born with an instinct to become a doctor or a statesman, but it was no good being a doctor or a statesman unless one cultivated the art, as the Chairman had done. He (Sir Malcolm) was connected with an Indian family. His father was in the Indian Civil Service, and most of his relatives lived in India. In his childhood he remembered relatives coming home and dying of liver abscess and all kinds of tropical diseases. Many of those diseases were extinct at the present time. For instance, liver abscess was now practically unknown. That change had been brought about as a result of the research work carried out in India. Medical men had investigated dysentery and found that amœbic dysentery caused liver abscess. Years ago people said it was due to nothing else but "pegs," but it was not; it was due to an infection. That infection had been to a large extent stamped out, and the disease which had killed so many white men had almost entirely disappeared. That was to the credit of the men who had given up their lives to live in a disagreeable climate amid all kinds of difficulties; and if the people of this country would only give them sufficient encouragement to carry on that work and let them know that those at home appreciated the work they did in the East, the diseases of the East would fall away one after another with extraordinary rapidity. It was an astounding thing to him that, in the midst of a great war, it was possible to hold such a large meeting to discuss the subject of tropical diseases in India, and that the Secretary of State for India should preside over it. It only showed that the people of this

country were trying to fight disease in earnest, and were determined that England should stand in the forefront in the fight against disease when the war was over. But it was no good coming to meetings and doing nothing; it was absolutely essential to fight while the war was on, in order to be ready when the war was over. The terrible disease of leprosy existed throughout India, China, and other parts of the world, and no serious attempt up till quite recently had been made to stamp out the disease. Recently his friend Sir Leonard Rogers, of Calcutta, had begun a piece of work which, in his (Sir Malcolm's) opinion, would bring forth good fruit. When he was in India in January 1914, he saw an Englishman, a member of one of the Services in India, terribly afflicted with leprosy. He was treated by Sir Leonard Rogers at Calcutta, and on seeing that man within the last few months he found that he was absolutely well; every manifestation of the disease had disappeared, although time alone would show whether the cure was permanent. He had that day seen an officer in this country who was afflicted with leprosy, and who had been under observation for the past few months. He had been carrying out the treatment recommended by Sir Leonard Rogers, and the improvement was so remarkable that he had never seen anything like it before in his life, with the exception of the case he had mentioned. That was the first step up the ladder towards the cure of leprosy, and if the India Office and other Departments continued to encourage research he believed the thousands of miserable people in India who were afflicted with leprosy, who were at present taken care of by the religious societies in India with a little support from the Indian Government, would be cured.

The chair was then vacated by Mr. Chamberlain, and was taken for the remainder of the meeting by Sir William Duke, K.C.S.I., K.C.I.E.

Surgeon-General G. J. H. Evatt, C.B., M.D., R.A.M.C., desired to thank the Secretary of State for India for having presided over the meeting. The fact that he had done so would prove of enormous benefit to the Medical Service in India, as the prestige of the Secretary of State was a tremendous asset. It was the first time, so far as he was aware, that the Secretary of State had presided over any meeting of medical men, and it was a very important departure which would have the most far-reaching effects, not only on the people in this country, but on the millions of India. It was of particular importance in view of the fact that the prestige of the Indian Medical Service had latterly fallen rather into the background. The paper that had been read was of the utmost importance in connection with the many thousands of European troops who served in India, among whom at one time there was a large percentage of deaths, due largely to the want of sanitary conditions among the natives who surrounded the cantonments. Research in medicine in India would be of benefit not only to the natives, but also to the soldiers who served in all parts of the Empire.

Major R. McCarrison, M.D., F.R.C.P., I.M.S., said, as one who had enjoyed, during the past fifteen years of service in India, the opportunities for medical research to which Sir Pardey Lukis had referred, he desired to bear testimony to the enormous field which India afforded for such research to those who had a special aptitude for it. He could not hope to add much to the information which Sir Pardey Lukis's paper had provided, but he might be permitted to refer to one or two points dealing with the results achieved in the past and the bearing of these on the prevention and treatment of disease in the present war. He thought it was not too much to say that Ross's demonstration of the truth of Manson's hypothesis that the spread of malaria was due to the mosquito laid the foundation of all tropical sanitation. No better illustration of the far-reaching effects of his discovery could be afforded than the triumph of American tropical sanitarians in the Panama Canal zone. Those great engineers, the French, had failed in the gigantic project of constructing the Canal, not through lack of engineering skill, but through lack of that knowledge which the genius of Manson, and of Ross of the Indian Medical Service, had provided. It was this knowledge, so skilfully applied by Surgeon-General Gorgas, which made possible this feat of engineering skill, and converted one of the most pestilential places of the earth into one of comparative salubrity. Nor was it too much to say that methods of treatment of the dysenteries which had their origin in India had resulted in the saving of tens of thousands of lives in the present war. Buchanan's saline treatment of bacillary dysentery was for long the only reliable means of dealing with cases of this disease, and even now that serum therapy was recognised as a specific means of cure, it was still a weapon of such potent effect that we could ill afford to dispense with it. Rogers's discovery of the specific influence of emetine in amœbic dysentery, when employed hypodermically, had robbed this dread disease of half its terrors, reduced its mortality enormously, and been responsible for the almost complete absence of its dangerous sequel—liver abscess—amongst the numerous sufferers from this form of dysentery during the present war. Nor must it be forgotten that the work of Haffkine, of the Indian Service, in 1893-1897 in perfecting a method of prophylactic vaccination against plague and cholera, had provided a potent means of defence against those diseases. During the Gallipoli campaign our troops, who had

received the benefits of prophylactic inoculation against these diseases, remained wholly free from them, while they prevailed in the Turkish trenches in the near neighbourhood. It was largely to the impetus which Haffkine's work gave to research in connection with prophylactic inoculation by bacterial vaccines that we owed the success which had crowned this practice in the case of fevers of the typhoid group. With regard also to relapsing fever, which prevailed in Egypt, the knowledge of its epidemiology and means of spreading, which emanated from India, enabled medical officers to combat it with success. In Mesopotamia, which, so far as the speaker was aware, was the only theatre of war where cholera had prevailed amongst the British forces, its spread was limited and its cure greatly facilitated by methods which the profession of medicine owed to medical research in India. These, then, were amongst the benefits which Indian medical research had made available for friend and foe alike in the present conflict of nations. They were an augury of still greater triumphs over disease which the future held for research workers in India.

Colonel Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., D.Sc., in proposing a vote of thanks to the author of the paper, and to Sir Havelock Charles for his kindness in reading it, said that the writer of such an interesting and able paper as that which had been read could have had no more eloquent exponent of it than Sir Havelock Charles. The Society was also pleased to welcome two very distinguished members of the India Office who had assisted in the discussion, and the Council of the Society would be only too pleased if at the discussions it was sometimes possible for the whole of the India Council to attend. Most of the papers read before the Indian Section of the Society were written by experts who had had long experience of the subjects with which they dealt, and who had had time to arrive at definite conclusions in regard to them.

Mr. Mirza Ali Abbas Baig, C.S.I., in seconding the motion, said that the opportunities for research in India were as vast and as varied as its population and its physical aspects. Among the multifarious blessings of British rule, none had been so manifest in its results as the application of Western scientific methods to Eastern conditions. He did not wish to disparage the native systems; they had their own methods of treatment which were sometimes most efficacious, as he knew from personal experience. But the native systems were practically stagnant when British medical men began their researches in India. Much was heard of the splendid work that was being done for India by the Indian Civil Service and by the engineers, but the quiet, unobtrusive and most beneficent work of the medical profession was not so well known nor appreciated. He was glad to hear the appreciation that had been expressed of the work of Haffkine by Major McCarrison. There was a great deal of prejudice in India against Haffkine perhaps, because he was a Russian Jew; but from his own personal knowledge he could fully endorse the encomiums that had been heaped upon him by Major McCarrison. The great problem in India at present was how to combat malaria, which was more destructive than all the other diseases combined. If the united genius of the medical profession in India could rid the country of that terrible scourge, it would be the greatest blessing that British rule could confer upon the country.

The resolution of thanks was then put and carried unanimously.

Sir Havelock Charles thanked the meeting, on behalf of the author and himself, for the very kind manner in which the vote of thanks had been moved, seconded and passed. In reply to Sir Patrick Manson's suggestion that Indians should be employed in the carrying out of scientific research, it might interest the meeting to know that of the twenty-nine appointments in the Bacteriological Department, six were held by outsiders, of whom five were Indians. The seconder of the vote of thanks had stated that the work of the Indian Civil Service and of the engineering profession in India was seen of man, but that the work of the medical men could not always be seen. Neither should it be seen, because the best work of the medical profession was that which was unseen. It was said of the women of ancient Greece that the best woman was the one with regard to whom nothing was said. That saying applied equally to the work done by the members of the Indian Medical Service. The work was not apparent in the press, nor in the public view, but in the households of the people. It was the personality of the civil surgeon that reached the heart of the Indian, and what more could be desired? That was what paid the civil surgeon for his onerous work. But it might be asked, was it good for a Government or a people ever to receive benefits and repay generally in words?

The meeting then terminated.

FIFTY YEARS OF INDIAN COTTON CROPS—1863-64 to 1912-13.

With Notes on the three last ones.

Area.

Only in the last five-and-twenty years have complete returns been officially published of the area under cotton, only about twenty of which apply to the half-century. Between the five-year periods ending 1897-98 and 1912-13, the quinquennial mean rose from $15\frac{3}{4}$ to $21\frac{1}{3}$ million acres,

equal to 36 per cent. The yield per acre on the official estimates improved from 64 to 76 lb., but on the "approximate crops" from 83 to 93 lb.

(The record crop of 1913-14, the first following the half-century, was gathered on an area of 25 million acres, equal to 85 lb. on the official estimate of 5,065,000 bales, but of 107 lb. on the approximate crop of 6,684,000 bales of 400 lb.)

Outturn.

In the twenty years ending 1882-83, the approximate crops averaged from 2 to 2¼ million bales, in the next five 2¾ million, followed by two of 3¼ million; in the subsequent one by nearly 3¾ million, and 4½ million in the next five, every year exceeding 4 and one 5⅓ million, while in the last five the average was just under 5 million.

(The crop of 1913-14, as just stated, approached 6⅔ millions, the following one 5¼ millions, and the last 5½ millions.)

In the last twenty years (of the fifty) the official estimates of yield—not previously issued—proved, on an average, too conservative by about 30 per cent. In the first five years ending 1897-98, they were too low by 850,000 bales (35 per cent.), in the next five by no less than 1,069,000 bales (41 per cent.), in the following period by 865,000 bales (23½ per cent.), and in the last by 913,000 bales (22⅔ per cent.).

Home Consumption.

Accurate returns of the quantities exported, as well as of the consumption by the mills, are available. Our notes are based on tables for the years ending June 30th, the end of the Bombay season, the export statistics being compiled from the returns of the Bombay Chamber of Commerce, and of the mills from those of the Bombay Mill Owners' Association. The only element of uncertainty is the local, other than mill, consumption. The official estimates regarding this have fluctuated in a remarkable manner, 400,000, 250,000, 750,000, and a year or two ago, after consultation with the Bombay Cotton Trades Association, a million bales. The data on which this estimate was arrived at have not been stated, but even if they are approximately correct the consumption of the country, for purposes other than spinning by the mills, has risen to 1¼ lb. per head. Half a century ago it was placed at 600,000 bales by Mr. Rivett-Carnac, the Cotton Commissioner of the Central Provinces and Berar. This was then equal to about 1 lb. per head. At that time the mill consumption was barely 65,000 bales, equal to about 3 per cent. of the two million bales produced, while the local consumption was equivalent to over 28 per cent. To-day the respective proportions are nearly 40 and 18 per cent. The mill consumption in the first half

Distribution of Indian Cotton Crops in Thousands of Bales of 400 lb.

5 Years Mean, ending June 30th.	Exports to				Home Consumption.			Exports and Home Consump'n.	Less Imports.	Approximate Crops.	Official Estimate of Yield.	Excess.	
	U.K.	Cont.	Far East.	Total.	Mills.	Local.	Total.					Bales.	Per cent.
1867-68	1,285	100	74	1,459	65	600	665	2,124	10	2,114	Not available.		
1872-73	1,243	230	94	1,567	114	604	718	2,285	12	2,273	Do.		
1877-78	721	500	60	1,281	193	619	812	2,093	15	2,078	Do.		
1882-83	454	753	90	1,297	355	638	993	2,290	16	2,274	Do.		
1887-88	574	829	55	1,458	640	677	1,317	2,775	17	2,758	Do.		
1892-93	235	1,158	98	1,491	1,083	716	1,799	3,290	25	3,265	Do.		
1897-98	94	831	299	1,224	1,351	729	2,080	3,304	22	3,282	2,432	850	35·0
1902-03	66	742	578	1,386	1,592	738	2,330	3,716	33	3,683	2,614	1,069	40·9
1907-08	91	1,242	597	1,930	1,917	746	2,663	4,593	33	4,560	3,695	865	23·4
1912-13	98	1,077	977	2,152	2,017	850	2,867	5,019	76	4,945	4,032	913	22·6
Years.												Mean	30·5
1913-14	166	1,899	1,472	3,557	2,143	1,000†	3,143	6,700	16	6,684	5,065	1,619	31·9
1914-15	169	623	1,408	2,200	2,103	1,000†	3,103	5,303	24	5,279	5,209	70	1·3
1915-16	137	431	1,898	2,466	2,100*	1,000†	3,100	5,566	7	5,559	3,819	1,740	45·6
1916-17												Mean	26·3

* Estimate. † Official estimate.

of the fifty years rose from 3 to 23 per cent., in the next five to 33 per cent., in the following fifteen fluctuated between 41 and 43 per cent., and in the last five averaged 41 per cent.

(Of the large crop of 1913–14 the ratio fell to 32 per cent., but in the last two averaged about 39 per cent.—2,100,000 bales.)

EXPORTS.

During the first half of the fifty years the proportion of the crops exported—1¼ to 1½ million bales—of the total available supply fell from 69 to 53 per cent., in the next five (one million) to 46 per cent., in the following two quinquennial periods (1½ million) to 37½ per cent., then rose (2 million) to 42½ per cent., and in the last five years (2 million) to 43½ per cent.

(In 1913–14 over 53 per cent. (3½ million) were shipped to foreign countries, 41½ per cent. in the next year (2¼ million), and 44½ per cent. (2½ million) in the last.)

The opening of the Suez Canal in the middle of November, 1869, marked a great change in the direction in which Indian cotton was exported. In the five years ending 1867–68 nearly 69 per cent. was shipped—61½ per cent. to Great Britain, 4½ per cent. to the Continent of Europe, and 3½ per cent. to China and the Far East. Twenty years later the respective shares were 21, 30, and 2 per cent., the direct despatches to the Continent *viâ* the Canal rapidly reducing England's earlier re-export trade. In the last five years of the half-century the proportions had changed to 2 per cent. to the United Kingdom, 22 per cent. to the Continent, and 20 per cent. to Japan principally and the Far East.

(Of the 1913–14 record crop, Great Britain took but 2¾ per cent., the Continent 28½ per cent., and Japan, etc., 22 per cent., while last season, owing to the war, the respective figures were 2½, 7¾, and 34 per cent.—total, 44¼ per cent.)

IMPORTS.

India imports little cotton from other countries. In the first forty-eight years of the half-century they averaged 25,000 to 35,000 bales, the bulk from Persia. But in 1911–12 over 135,000 bales (of 400 lb.) were imported from America and Egypt, and 175,000 bales in the following year, dropping again in the last three to less than the former normal.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

British Colour-making. — The new British colour-manufacturing industry makes more progress than is popularly known. The output of coal-tar dyestuff increases in current quantity, despite an accident which severely hampered the production of alizarine. In quality the British makes are better than ever, and impartial witnesses give their admiration spontaneously to the success attained in standardising successive lots. The variety is increasing, and the production of fair quantities of an entirely satisfactory sapphirol, a bright blue for wool dyeing, is one event which can be noticed. The manufacture of fully half a dozen of the most complex and valuable colours has been mastered in a textile works, and one of these days the country will awaken to the discovery that surprising headway has been made under circumstances of the utmost difficulty. Preparations for a much greater production of intermediates and colours are well advanced, and the records of the progress made elsewhere give the feeling that English manufacturers are by no means doing badly. Probably much more money is being made by American colour-makers, but no available reports go to show that either they or the Japanese colour-producers are earning any good name for their dyes.

Artificial Silk.—Artificial silk has the same base as paper, and its manufacture is affected in a measure by the difficulty of receiving wood pulp. Fortunately, arrangements have been made to secure a specified supply during the next twelve months, and the export of articles manufactured with artificial silk should not suffer. Wood pulp is indispensable to viscose silk, and when applied to that purpose it is distinctly more thriftily used than in the manufacture of common paper. The calculation goes that the pulp consumed in manufacturing the £2½ millions of exported textiles containing artificial silk represents merely 2 per cent. of the completed value. The yarn made from viscose is of an outstanding brilliancy, so that comparatively little of it goes a long way in seasoning light cotton fabrics to the taste of the tropics. Proof of the perfection that has been attained in converting wood pulp into lustrous yarn may be found in the plain cloths now made with a face entirely composed of this material. The test is the most severe one that could be applied, and apparently no fault is to be found with the way that the fabric stands washing and ironing. The original silks dissolved upon washing, and their successors were spoiled by immersion in water, while the hot iron played havoc with the colour.

"*Ozone*" *Fibre.* — Artificial silk is still the only well-proven substitute for the natural fibre, and although new natural fibres continue to be proclaimed, their efficacy as alternatives to the old-established materials remains doubtful. Even the "ozone silk" discovered in Saginaw, Michigan, must be included for the present in this class, for the particulars rendered about it relate rather to the prospective profits than to the real utility of this curiously named fibre. Like the German typha, it can be raised on swamp land, but there is no absolute proof as yet that the fibre will fetch the dollar a pound

which would enable its happy cultivators to earn £200 per acre. It is neither an uncommon nor a good sign that the possessor of some recondite fibre should harp more upon its profits than its use.

Looms for Soldiers.—A scheme reported to have the sanction of the War Office has for its object the teaching of hand-loom weaving to disabled soldiers. Workshops are to be opened in various centres in Scotland, and in some cases looms are to be installed in the home. It is an attempt, apparently, to revive the idyllic days at the same time that the broken man is given a means of livelihood. It would be well if all such schemes were reviewed in the light of economic advantage. A hand loom in its essence is a power loom operated slowly by hand and foot, giving a low rate of production and conferring no clear advantage upon the quality of cloth produced. The work is, of course, more laborious than upon power looms, and superfluous labour is not in itself desirable for men of impaired strength. Were lathes, sewing-machines, or knitting-machines, to be erected in any number in a workshop it is certain that nobody would think of driving them by hand if power could be raised or borrowed, and the reason for an exception in the case of looms is not evident. If looms are not grouped in workshops but scattered in cottages, there is the by no means inconsiderable labour of fetching materials to be woven and delivering the woven cloth. It must be submitted that these features are disadvantageous to a scheme of which the first purpose is the well-being of the workman, and they are assuredly not necessary ones.

A Cotton Annual.—The reappearance of the *Cotton Year Book* of 670 pages, additional to its advertisements and diary, might provoke a doubt of the actuality of the paper famine, and all the more as its price is the exiguous half-crown charged for its slenderer predecessors in less expensive days. The book grows with the developments, mechanical and commercial, of which it treats, and nothing else that is published gives so full an insight into the work of the industry. A volume first for the reference of people engaged with cotton, it is suggestive to other manufacturers and invaluable to seekers of an explanation. The manufacture of textile machinery, other than for specially approved purposes, may be in suspense, but the interest in alternative systems is very much alive, and in keeping the ball rolling an annual like the *Cotton Year Book*, 1917, renders inestimable service.

Burmese Specimens.—It is rather with clothes than cloths that Miss Laura E. Start deals in "Burmese Textiles" (Bankfield Museum Notes, F. King, Halifax, 3*s.* 6*d.*). The materials are Shan and Kachin garments collected by Mr. E. C. S. George, C.I.E., and made and worn by tribespeople living largely out of the world. The account is an eminently painstaking description of native needlework and native wear, with illustrations clearly exposing the ornamentation, and with dimensions stated to the fraction of a centimetre. The selection sustains the author's high opinion of the taste and fertility of the craftswomen, and it may be hoped and believed that the pains taken over the description will in due time form material for the comparative study of design.

Mill Life.—The idea that aptitude for textile work is hereditary among families resident in the textile areas is as well received there as elsewhere. Proof or disproof is hard to get, and the point frankly rests on opinion. It is, however, hardly a matter of opinion that those reconcile themselves best to mill life who have gone to the mill from early years, seen their friends and relations going, and have grown up to accept mill conditions as normal. Those who stay best at the work become naturally the best workers, and it is at any rate arguable that environment counts for as much as heredity and is more clearly traceable. The case exhibits itself in particular as well as in general, and notably in the willingness to live in one district and work in its mills, although not in those of a short distance away. The town-dweller can barely be persuaded to stay in mills called "in the country," and newcomers from beyond the textile radius can hardly be induced to make the mill their final destination. The matter is more one of amenities than of wages. His own district has given the employer his best workers hitherto, but it would be useful to know how much of this is due to an unattractiveness which repels those who have not been born in the surroundings. These conditions react on the minds of native girls and boys, who shun the occupations for which they have a reputed hereditary skill to devote themselves to trades in which they start at no advantage. The necessity for making the mill a more obviously agreeable place in which to earn a living is heightened by the proposals to raise the school age. In general, the reluctance to enter the factory increases with age and education, and the preference of those who should provide the detail labour will inevitably have to be met.

OBITUARY.

LORD ALLERTON, F.R.S.—The death of Lord Allerton took place on the 4th inst. at his residence in London.

William Lawies Jackson, first Baron Allerton of Chapel Allerton, Leeds, was born at Otley in 1840.

After being educated at a Moravian school, he devoted his energies to tanning, and became a prominent member of the leather industry. In 1876 he unsuccessfully contested the Parliamentary Division of Leeds, but four years later he became one of the members. In 1885 the city was rearranged into five divisions, and he was elected for the Northern Division, which he continued to represent until 1902, when he was created a Baron. He was Financial Secretary to the Treasury in 1885-86 and from 1886 to 1891, and Chief Secretary for Ireland in 1891-92. For over twenty years he was Chairman of the Great Northern Railway Company; he was also Chairman of the Royal Commission on Coal Resources, and of the South African Commission in 1896.

Lord Allerton was elected a member of the Royal Society of Arts in 1885.

GENERAL NOTES.

Victoria and Albert Museum.—Earl Beauchamp has lent for exhibition at the Victoria and Albert Museum the important collection of miniatures and snuff-boxes from Madresfield Court. The exhibition contains 372 miniatures in water-colour, oil, and enamel, by English and foreign artists, chiefly of the sixteenth, seventeenth, and eighteenth centuries, together with thirty-one snuff-boxes, chiefly French, and dating from the eighteenth century. It is arranged in Room 84, adjoining that in which the miniatures lent by the Duke of Buccleuch are exhibited (Room 83), and visitors will find in the collections shown in these two rooms representative examples of the work of practically every English miniature artist of importance of the sixteenth, seventeenth, and early eighteenth centuries.

Camphor.—The production of camphor in Japan for the year ending March 31st, 1917, is estimated, by H.M. Commercial Attaché at Yokohama, at 1,627,422 kin,* an increase of 26,607 kin as compared with the actual yield in 1915–16, while the estimated production in Formosa amounts to 5,014,743 kin, an increase of 394,561 kin, as compared with the actual yield in the preceding year. The production of camphor oil in Japan for 1916–17 is estimated at 3,210,494 kin, an increase of 209,073 kin as compared with the actual yield in 1915–16; the estimated production in Formosa is 7,827,560 kin, or 946,328 kin in excess of the actual yield in 1915–16.

Piassava Industry of British West Africa.—West African piassava is a brush-making fibre obtained from the leaf-sheaths of the wine-palm (*Raphia vinifera*). It is produced in most of the British West African possessions, but chiefly in Sierra Leone. The exports of piassava from that colony in 1914, according to the *Bulletin of the Imperial Institute*, were 983 tons, valued at £19,492, as compared with 839 tons, valued at £12,280 in 1913. The exports from Nigeria were 403 tons, valued at £5,117 in 1914, as compared with 228 tons, valued at £2,806 in 1913. No exports of the fibre from Gambia or the Gold Coast have been recorded in recent years, but the industry in Gambia appears to be worthy of attention with a view to development. The palm grows on the banks of the river, which is navigated by ocean-going vessels.

* A kin is 1·3 lb.

Sugar in Hong-Kong.—In a report on the Hong-Kong sugar trade, the American Consul-General mentions that the Chinese Government has been conducting experiments for some time with a view to introducing sugar-beet culture in China. Experiments have been greatly interfered with by the difficulty of securing seed, which is said to have increased in price from $8 to $58 per bushel, with very little to be had at any price; but sugar experts in Hong-Kong are of the opinion that the day is not very far distant when China will produce most, if not all, of the sugar required for its people, and thus release a large amount of Java and Philippine sugar for use in other parts of the world.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

April 18. — Horace M. Thornton, M.I.Mech.E., "The Application of Coal Gas to Industry in War Time: its National Importance." Sir George Thomas Beilby, LL.D., F.R.S., Chairman of the Fuel Research Board, will preside.

April 25.—Sir Francis Fox, M.Inst.C.E., "Flour and Bread." Captain Charles Bathurst, M.P., Parliamentary Secretary, Ministry of Food, will preside.

May 2.—J. C. Shenstone, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future."

May 9.—Professor William Ripper, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

May 16. — Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

April 19.—R. S. Pearson, I.F.S., F.L.S., Imperial Forest Economist, "The Industrial and Economic Development of Indian Forest Products." Sir Robert W. Carlyle, K.C.S.I., C.I.E., Member of the Viceroy's Council, 1910–15, will preside.

May 17.—D. T. Chadwick, I.C.S., "The Future of Indian Trade with Russia."

Howard Lectures.

Monday afternoons, at 4 p.m.:—

William George Fearnsides, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 16...Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. J. I. Munro, "The Witness of Philology to the Truth of the Old Testament."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Mr. J. G. Head, "The Effect of War Conditions on Urban Property."

Electrical Engineers, Institution of (Local Section), Mining Institute, Newcastle, 6.45 p.m. Mr. C. Vernier, "Wayleaves."

Tuesday, April 17...Petroleum Technologists, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. H. S. M. Jack, "The Development of the Petroleum Industry in Assam."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. R. Beazley, "Russian Development. Lecture I.—The Old Free Russia."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Annual General Meeting.

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 3.30 p.m. Annual General Meeting.

8 p.m. Mr. F. de Jong, "Ornamental Plastering and Decoration."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mrs. L. I. Veley, "Some Aspects of Animal Photography."

Colonial Institute, Caxton Hall, Westminster, S.W., 4 p.m.

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. C. D. Sherborn, "The Original Fragments of Skin of the Gorilla sent by Du Chaillu to Owen, from the Gaboon, 1862." 2. Mr. E. Heron-Allen, Lantern Exhibition illustrating the Mussel-fishery and Foraminifera of Esnandes (La Rochelle), and the early work of Alcide d'Orbigny.

Wednesday, April 18 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. H. M. Thornton, "The Application of Coal Gas to Industry in War Time: its National Importance."

Aeronautical Society of Great Britain, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Dr. W. H. Hatfield, "Steel and Steel Alloys."

Meteorological Society, 70, Victoria-street, S.W., 5.30 p.m. 1. Mr. E. G. Bilham, "The Diurnal Variation of Atmospheric Pressure at Benson, Oxon., during 1915." 2. Lieutenant C. D. Stewart, R.E., "Atmospheric Electrical Phenomena during Rain."

Geological Society, Burlington House, W., 5.30 p.m. Professors H. H. Swinnerton and A. E. Trueman, "The Morphology and Development of the Ammonite Septum."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. de la Mare, "The Sea in English Fiction."

Thursday, April 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. R. S. Pearson, "The Industrial and Economic Development of Indian Forest Products."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Dr. D. H. Scott, "The Heterangiums of the British Coal-Measures." 2. Mr. E. S. Goodrich, "Hypophysis and Premandibular Cavities: a Suggestion." 3. Miss N. Layard, "Wooden Scratching Tools made by an African Parrot; illustrated with specimens and lantern-slides."

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Rev. R. R. Hyde, "Welfare Work with Young Employees."

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. E. Newbery, "The hydration of ions and metal overvoltage." 2. Mr. H. Nomura, "The pungent principles of ginger. Part I.—A new ketone, zingeribone, occurring in ginger." 3. Messrs. P. C. Ray, M. L. Dey, and J. C. Ghosh, "Velocity of decomposition and the dissociation constant of nitrous acid." 4. Mr. F. L. Pyman, "The alkaloids of ipecacuanha." (Part II.) 5. Messrs. R. O. Griffith, A. Lamble, and W. C. McC. Lewis, "Studies in catalysis. Part VI.—The mutual influence of two reactions proceeding in the same medium." 6. Mr. W. C. McC. Lewis, "Studies in catalysis. Part VII.—Heat of reaction, equilibrium, constant and allied quantities from the point of view of the radiation hypothesis." 7. Mr. A. H. Salway, "Note on the isolation of methylnonylketone from palm kernel oil." 8. Mr. J. N. Rakshit, "Metallic derivatives of alkaloids."

Royal Institution, Albemarle-street, W., 3 p.m. Professor H. S. Foxwell, "Industrial Finance after the War. Lecture I.—The Character of the Industrial Struggle of To-day."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m.

Historical Society, 22, Russell-square, W.C., 5 p.m. Mr. H. P. Biggar, "Charles V. and the Discovery of Canada."

Numismatic Society, 22, Albemarle-street, W., 6. p.m.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. 1. Mr. W. Whyte, "Stope Measurement at Messina." 2. Mr. F. Gillman, "Platinum in Spain."

Friday, April 20 ... Royal Institution, Albemarle-street, W., 5.30 p.m. Professor R. H. Biffen, "The Future of Wheat-Growing in England."

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, Westminster, S.W., 6 p.m. Address by the President.

Saturday, April 21...Royal Institution, Albemarle-street, W., 3 p.m. Professor G. H. Bryan, "The Principles of Aerial Navigation." (Lecture I.)

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FRIDAY, APRIL 20, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, APRIL 25th, at 4.30 p.m. (Ordinary Meeting.) SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

Thursday afternoon, April 19th, 4.30 p.m.; SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., Member of the Viceroy's Council, 1910-15, in the chair. A paper on "The Industrial and Economic Development of Indian Forest Products," by R. S. PEARSON, I.F.S., F.L.S., Imperial Forest Economist, was read by Laurence Mercer, C.I.E., late President, Imperial Forest Research Institute and College, Dehra Dun.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

SIXTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 18th, 1917; SIR GEORGE THOMAS BEILBY, LL.D., F.R.S., F.I.C., F.C.S., Chairman of the Fuel Research Board, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Baker, Arthur, Denehurst, Darwen, Lancashire.

Datta, Gour Chandra, 14, Waverley House, Kenton-street, Russell-square, W.C. (1)

Field, Wilford, Ivydene, Heston, Middlesex.

Ho Tung, Sir Robert, J.P., The Neuk, 83, Peak, Hong-Kong, China.

King, William W., Messrs. Typke and King, Ltd., Crown Chemical Works, Mitcham Common, Surrey.

Lim Peng Siang, 61, Kling-street, Singapore, Straits Settlements.

McKillop, Arthur Torrens, Ministry of Agriculture, Cairo, Egypt.

Patuck, Rustom Sorabji, The Vizianagram Mining Company, Chipurupalle P.O., Vizagapatam, Madras, India.

Shroff, Shiavaxsha Darabsha, Patel Mansion, Cumballa-hill, Bombay, India.

Smith, Robert Tweedy, 89, Chancery-lane, W.C. (2)

Vidyabhushan, Dr. Lingish (Shri Mahabhagavat), Ph.D., Kurtkoti, Dharwar, Bombay, India.

The following candidates were balloted for and duly elected Fellows of the Society:—

Brunjes, Thomas Alfred, F.C.S., M.S.C.I., 94, Waller-road, New Cross, S.E. (14)

Casson, Herbert N., 4, Lincoln's Inn Fields, W.C. (2)

Gardiner, Frederick Ambrose, F.L.S., 12, The Ridgeway, Golders Green, N.W. (4)

Hyett, John E., A.R.C.A., 4, St. Oswald's Studios, Sedlescombe-road, West Brompton, S.W. (10)

Noronha, Edward Joseph, J.P., Messrs. Noronha & Co., Hong-Kong, China.

Vickery, James Harris, LL.B., 4, Lincoln's Inn Fields, W.C. (2)

The paper read was—

THE APPLICATION OF COAL GAS TO INDUSTRY IN WAR TIME: ITS NATIONAL IMPORTANCE.

By HORACE M. THORNTON, M.I.Mech.E.

When I read my last paper before the Society, "The Uses of Coal Gas for Industrial Purposes"—now over two years ago—I then suggested that we were witnessing the dawn of a new era in industrial heating. On that occasion illustrations were given, by lantern-slides, of about seventy applications of coal gas to our largest national industries, representative of a very

much greater number known to be in operation. In spite of these already numerous uses, industrial gas was then merely in its early development, and the realisation of the universality of its service was only growing gradually upon the manufacturers of this country. To-day he would be a bold man indeed who would define the limits of its penetration. The extent to which British industries, and therefore the nation at large, are under tribute to this great servant of the twentieth century is very much clearer now than it was even two brief years ago. It is probable that two years of war have taught us, as a nation, more than two decades of peace. Much that we have been forced to learn we would willingly forget; but if there are to be found any valuable products from this time of outpouring of life and treasure, one of the chief will surely be the great progressive movements which, under the stress of war-time conditions, have characterised our foremost industries. It has been so with industrial gas. Uses hitherto unknown have been discovered, uses hitherto regarded as impossible have been proved successful. Town gas, of which we thought we had known the full story for many years, and the decline in the use of which had often been prophesied—that common and ordinary lighting, cooking, and heating agent, delivered to us so simply through pipes into our homes—has proved to be much more potent and far more serviceable than our familiarity with it allowed us to conceive. To-day I wish to take up the story where I left it on the occasion of the last paper in March, 1915, and to give some account of the progress that has been made in the interval. At that time I gave, among details of many industries, particulars of a few of the uses of gas that were in operation for the production of armaments and munitions of war generally. To-day, so extensive are the uses of gas for these purposes, that they provide more

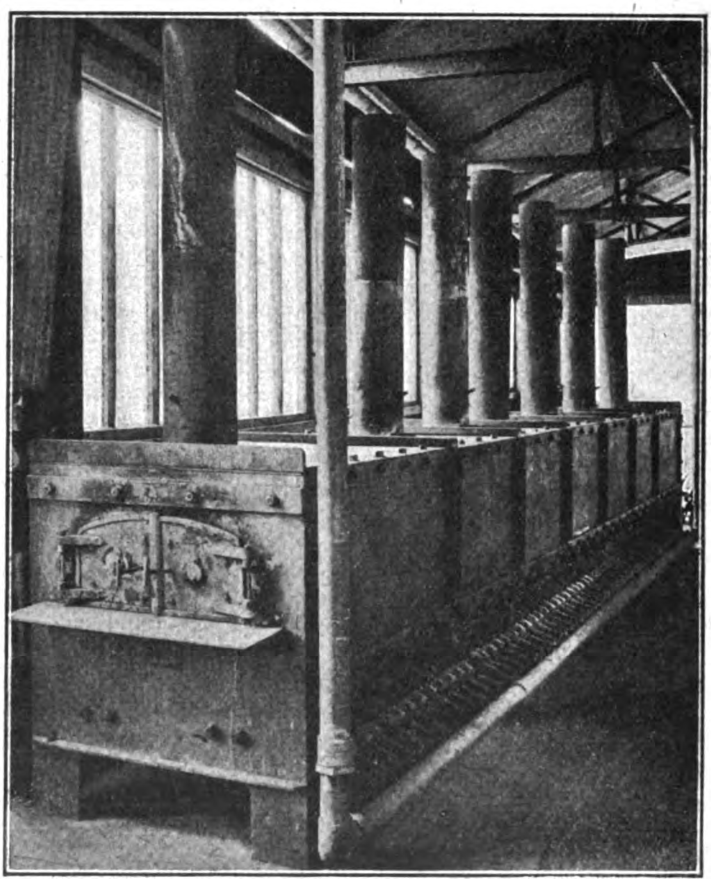

FIG. 1.—ANNEALING TOOL-STEEL BARS IN OVEN FURNACE, 22 ft. 6 in. long.

than sufficient material for this paper—indeed, it is necessary, if your patience is not to be unduly tried, to restrict ourselves in the first place to a consideration of the uses of the gas furnace in the engineering world, omitting the wide application of this fuel to the glass, cotton, cloth, hat, boot, confectionery, food and many other trades, with which I dealt in my last paper and which have during the last two years found still further scope for the utilisation of gas. I also desire to devote some time to the modern movement in regard to welfare work in factories and the part that gas plays in this important subject.

achieved with the utmost speed and in the face of an already heavy withdrawal of labour for military requirements. Under the stress of this need of maximum quantity with minimum labour at maximum speed many a manufacturer requiring a heat-treatment process—and heat is a well-nigh universal necessity in manufacture—sought and found the solution to his problem in the use of gas.

Let us look a little more closely into the facts as presented to industry when the demand for munitions of all kinds became insistent, and we shall see the part that gas for production purposes has played.

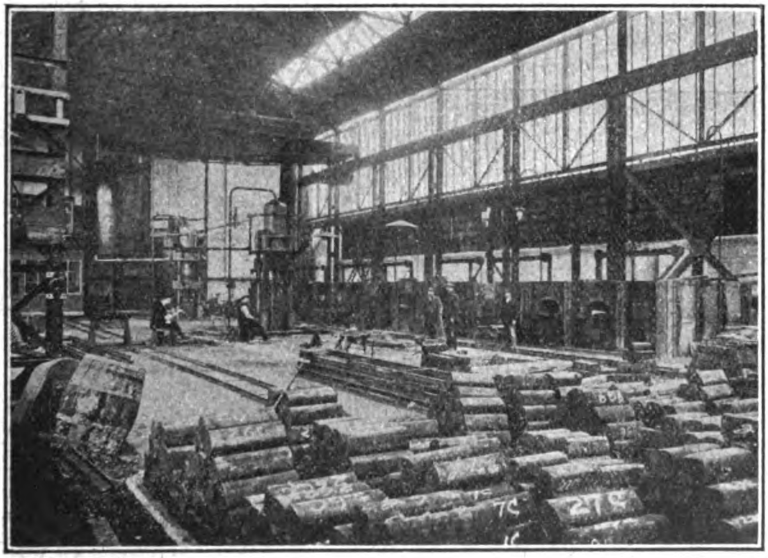

FIG. 2.—BILLET HEATING IN COKE FURNACE.

SOME REASONS FOR THE POPULARITY OF THE GAS FURNACE.

Before passing to the examples I wish to give and the illustrations I have to show, it will be of interest to trace some of the reasons which have led to the result I have described. Numerous and complex problems faced the engineers and manufacturers of this country anxious to respond to the call for "munitions, more munitions, and still more munitions." In many cases it was the problem of an immediate and enormous increase in normal production; in others, in many others, it was the problem of converting factories from the production of peace-time commodities to the turning out in vast quantities of war-time necessities.

Whatever the circumstances, the demand was for increased productivity, multiplied many-fold on ordinary output, and this was required to be

1. The volume of labour was reduced and, as events have proved, the manufacturer had to be prepared to face a still further decline. The gas furnace economised valuable labour, as no stoking was required; no fuel had to be transported or stored; no clinkering had to be done; no ashes had to be removed; very much less time was lost waiting for the furnace to heat up.

2. Existing factories had to be utilised to the full extent of their capabilities, for while we admire the gigantic enterprises of the Ministry of Munitions in erecting new factories these took time to build, and a great accession to our materials of war was required immediately. Here the gas furnace, compact, self-contained and mobile, showed to advantage. It gave economy in space, and made possible an increase in output per unit of factory area. No smoke-stack was required; the choice for the position

of the furnace was practically unlimited, enabling it to be brought into close proximity to the machine worker. No space was required for the storage of fuel or ashes. The capital expenditure in many cases was lower than for coal furnaces. No special structural alterations to the factories were required; no foundations were necessary; no provision had to be made for the extraction of smoke, soot or dust from the workshop.

3. The most vital need was for an instantaneous, and yet abnormal, acceleration in production. The gas furnace, with its easy, accurate control of temperatures and its constancy of action, "speeded up" the output, increasing the number of operations—annealing, hardening, melting, etc.—per working day by, in many cases, 100 per cent. over crude heating methods. Its fuel was always available, and at a constant calorific value. With reasonable care there was no spoilt work and no "rejects" owing to irregular heating. The time required for each operation could be definitely ascertained and the work could be performed at a uniform speed, enabling the works manager to depend on a constant supply of his heat-treated materials for the other departments of the factory.

The Uses of Gas Furnaces in the Production of Munitions.

We will now, with the aid of lantern-slides, examine a few of the actual uses to which gas furnaces have been put during these last two eventful years.

Dealing first, as is fitting, with steel, the slide shows a large natural-draught oven furnace, with inside length of 22 ft. 6 in. by 2 ft. by 1 ft., for annealing bars of tool-steel (Fig. 1). It takes a load of 4 tons per charge, and is one of the biggest coal-gas furnaces in operation in this country, consuming about 2,750 cubic ft. per hour. The second slide also deals with annealing high-speed steel bars, but in a low-pressure-gas-and-air furnace, which is in Sheffield a very popular type for this purpose. This furnace takes charge of several tons, according to the section of the bars, and, at a temperature of about 850° C., it consumes approximately 3,500 cubic ft. per ton annealed. Steel billets for many purposes are annealed or normalised in gas furnaces. I would, however, like to show you a suite of coke-heated regenerator furnaces for billet heating (Fig. 2). The mention of this fuel is not at all incompatible with our theme to-day, as it is the primary by-product of all gasworks. The slide shows a gas furnace for the "nosing" or "bottling" operation of shells. The next slide illustrates a gas furnace, also used in Sheffield, for the heat treatment of armour-piercing shells. After the shells have been machined, etc., they are carefully washed, and our slide shows gas-heated circulators providing the necessary hot water (Fig. 3). They are then varnished inside and stoved in the gas oven shown in the centre of the picture. Our next slide illustrates a much larger factory, and shows a battery of drying ovens in course of erection. The rails for the trolleys, to facilitate

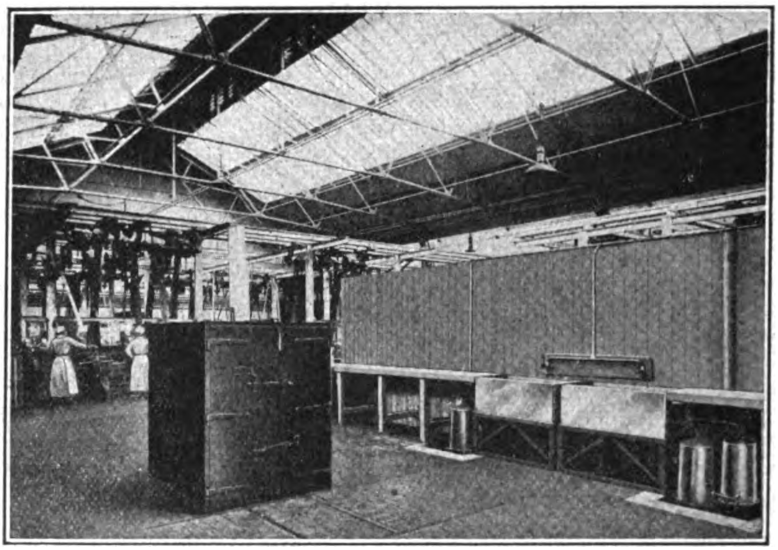

Fig. 3.—Shell Washing and Drying Plant.

handling when loaded with heavy shells, will be noted.

From the shell we pass to the gun. Here gas finds its principal service in the manufacture and repair of howitzers and guns from the short 4·5 in. howitzer to the long naval gun, and the heights of the gas furnaces range from 8 ft. to 70 ft. In this case a photograph was impossible.

Next we turn to the rifle, and our slide shows furnaces for the hardening and case-hardening of rifle parts (Fig. 4). For this work gas furnaces are eminently suitable. Rifle breeches are also annealed in gas furnaces.

Our next four pictures are of the heat-treatment department of one of our largest works. All the furnaces you will see in the four slides are under one roof, and all use coal gas supplied from the gasworks. The first of the four shows natural-draught oven furnaces for the heating of machine-gun barrels; the next is for other component parts of similar arms; the next shows various furnaces for annealing and hardening; the next a fine row of gas and air blast furnaces for similar work.

To assist you to an impression of the extent of this heat-treatment shop, I have had prepared a slide combining the four photographs shown (Fig. 5). This is undoubtedly one of the finest equipments in the country, and the selection of gas furnaces is confirmation of the claims I have advanced earlier in this paper.

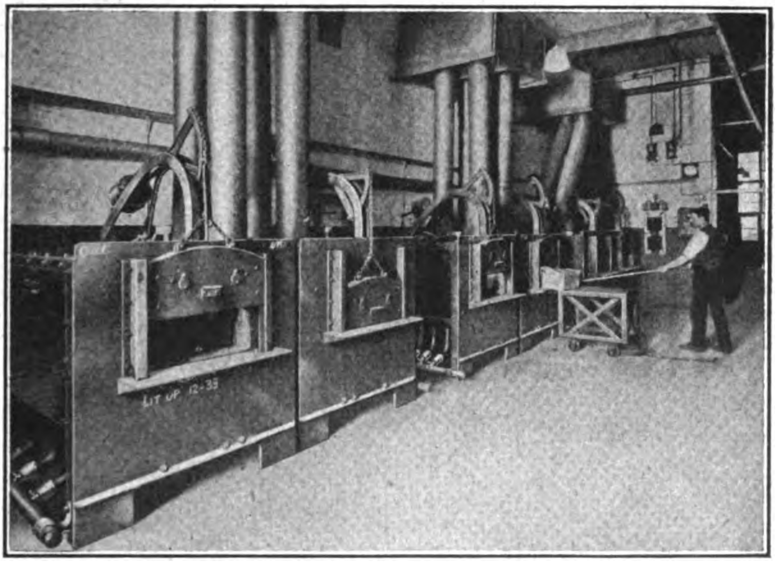

Fig. 4.—Case-hardening Component Parts of Rifles in Reverberatory Oven Furnace.

The Manufacture of Tools.

The use of gas furnaces in the manufacture of tools of all kinds—cutters, reamers, lathes and planing tools, broaches, etc.—has expanded enormously since the war began. The careful heating of high-speed steel to critical temperatures, so necessary for good results, is accomplished perfectly with gas. Our next slide portrays hardening furnaces in a large Midland factory (Fig. 6). The work of a shop of this kind is so complex, and so many different types of tools are produced, that it is impossible to go into details. Piercers or punches for shell bodies, spade-cutters for shell-boring, taps, dies, twist drills, broaches, and many other tools necessary for engineering work are all hardened in these furnaces. In the next illustration you see a man working at one of the popular twin-hardening furnaces. Air blast is used at about 1 lb. pressure per square inch. The tools are pre-heated in the upper chamber to about 900° C., and then immediately transferred to the lower chamber at about 1260° C.

Nickel-chrome and other alloy steels come into very wide use for war service. For all purposes where the highest possible tensile strength compatible with lightness is desired, these steels are in demand—for example, for the vital parts of motor-cars and aeroplanes, steering levers, axle levers, stay-rods and landing-gear lugs, cam shafts, etc. A point of particular interest is the

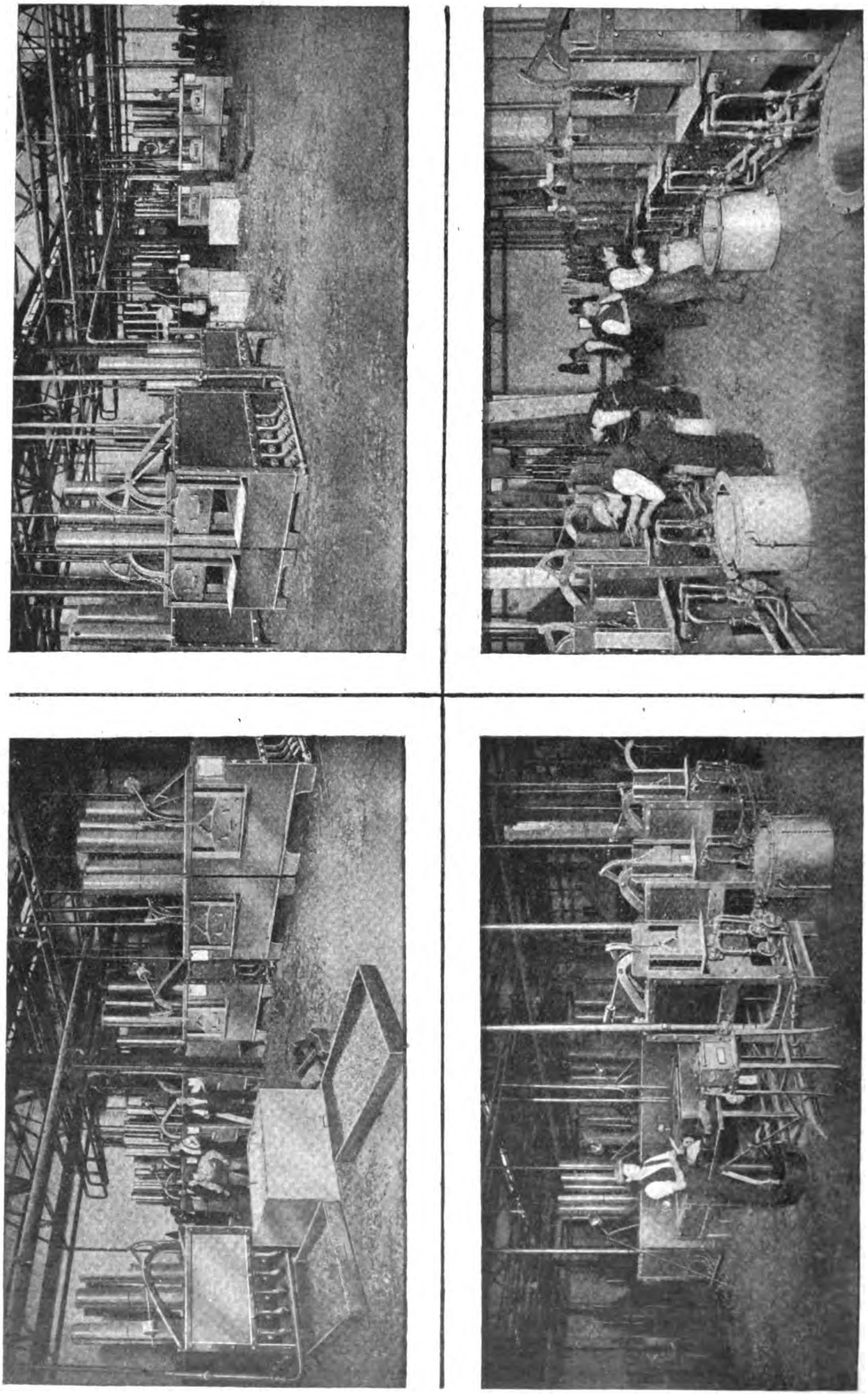

FIG. 5.—"RICHMOND" PATENT FURNACES, INSTALLED IN ONE OF THE LARGEST HARDENING SHOPS IN THE COUNTRY.

heat treatment of the special alloy steel used for the plates for the steel helmets of our soldiers. For this purpose the low-pressure gas and air furnace (as seen on the screen) has been found to be pre-eminently suitable on account of its equal heating and non-oxidising condition.

Coming now to the furnaces used for case-hardening, the next slide is of the hardening shop of a large cycle company (Fig. 7). The furnaces here are employed in carburising component parts of bicycles and motor-cycles—cones, cups, speed-gear parts, pedal centres, spindles, etc.

The next slide takes us to the annealing of wire (Fig. 8), of which huge quantities are used by both Army and Navy for many purposes. The coils, weighing about 1 cwt. each, are taken to 800° C. or thereabouts, and then are cooled off gradually in soaking pits. The gas consumption is about 2,000 cubic ft. per ton.

A gas-heated lead-bath furnace for annealing aeroplane stream line wires is now seen on the screen. The furnace is 15 ft. long and is of the down-draught type. In mentioning aeroplanes, another interesting use for gas comes to mind—viz., for heating the dope room by radiators, as seen by the photograph (Fig. 9). This room has to be maintained at a high temperature to dry the aeroplane wings, etc. The next illustration shows numerous aeroplane parts spread out for drying, and the British identification discs may be seen. In this factory there are fixed eighty of these gas-steam radiators.

Although I have by no means exhausted the use of gas furnaces for steel, I think the other operations which will occur to you are represented in one way or another in the examples I have given. We will, therefore, now pass to the non-ferrous metals, aluminium, etc.

Gas in the Non-ferrous Metal Trades.

First, the melting of brass, copper, aluminium, cupro-nickel, etc., is being accomplished by gas in ever-increasing quantities for the manufacture of rifle and machine-gun cartridge cases, shell cartridge cases, driving bands, fuses, etc.

The next slide shows melting furnaces, not in an industry peculiar to war time, but possessing more than a passing interest—viz., the silver and bronze melting house at the Royal Mint, where gaseous fuel has shown an economy over coke in respect of output, cost of fuel, cost of graphite goods, and cost of labour. The next slide is a photograph of a battery of twelve 130 lb. high-pressure-gas-heated pit furnaces used for the production of 100 lb. billets. The next photograph is a battery of six high-pressure-gas-heated furnaces for melting aluminium.

Gas furnaces are also employed for heating the brass billets for extruding into the rod, as well as for heating up ingots to be rolled into billets and subsequently into strips. The first slide on this subject shows part of a suite of eleven furnaces for heating brass billets. Thirteen

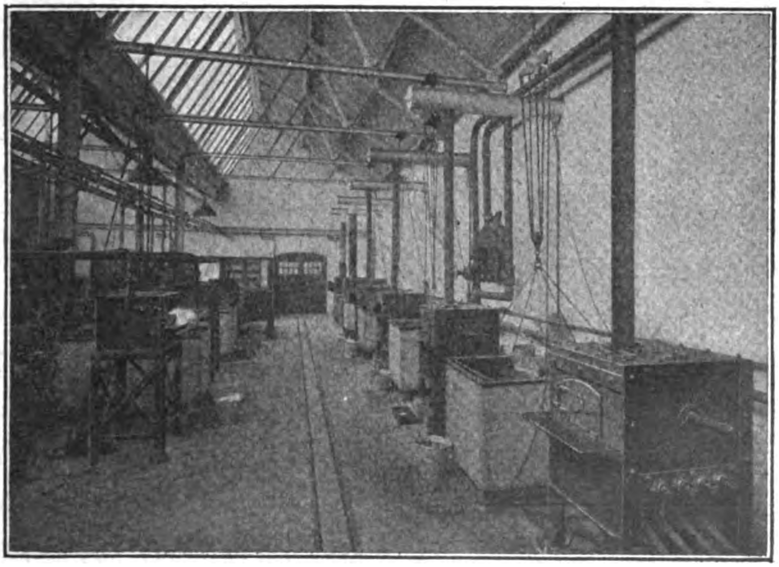

Fig. 6.—Suite of Tool-hardening Furnaces.

thousand per day are dealt with in these eleven furnaces.

The next slide is of a different type of furnace for a similar purpose. This, as will be at once apparent, is of the inclined type, the billets gradually rolling down as the sufficiently heated ones are withdrawn. This work has been largely taken up in the Midlands by manufacturing silversmiths, whose plant was readily adaptable, and who found gas furnaces an immediate and convenient means of providing the necessary additional heat treatment. Our next slide illustrates four furnaces, fitted with endless chain conveyors for heating up brass billets before pressing (Fig. 10). Each of the trays is seen on the next slide in connection with the rifle cartridge in the annealing of cupro-nickel sheets before breaking down, rolling and stamping or drawing into the sheath for the bullet (Fig. 11).

Finally, before we leave the subject it will be interesting to see one of the erecting shops in a large works engaged in the manufacture of gas furnaces (Fig. 12). Accuracy and control of temperature being always required of gas furnaces, it is essential the manufacturer should know exactly what his furnaces can do with different materials, and the next picture shows part of a test room with blower, pyrometer outfit, etc., in the same establishment (Fig. 13).

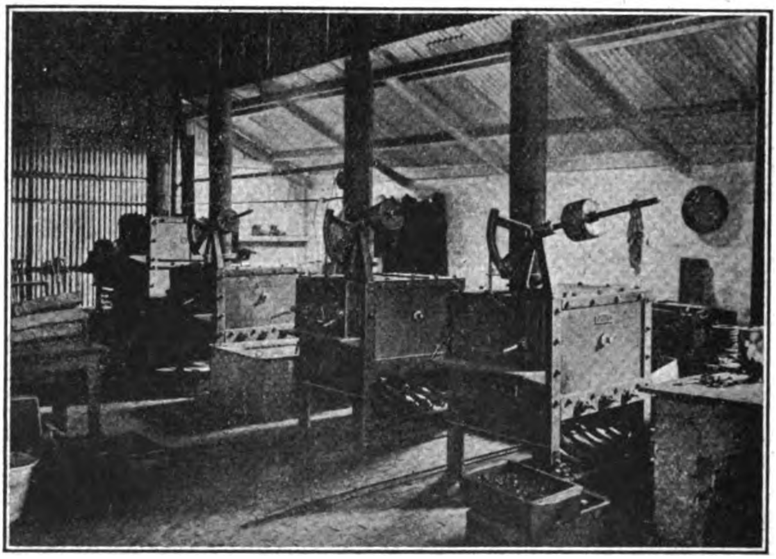

FIG. 7.—RE-HEATING CYCLE AND MOTOR-CYCLE COMPONENT PARTS.

which you can distinguish takes twenty minutes to travel through the furnaces, at the end of which time the heating is completed.

There are numerous other brass parts which receive heat treatment in gas furnaces, but we must pass on to copper. The picture presents us with a view of part of an installation of furnaces, each 12 ft. long, for annealing copper blanks prior to pressing or drawing and cutting into small sections for driving bands. After each heating operation (five in all are necessary) the metal is quenched in the tanks seen in the foreground. The bands themselves are heated in gas furnaces prior to their use.

The next photograph illustrates the annealing of rifle cartridge cases prior to the stamping and drawing processes. Another gas operation

I do not venture to claim that this recital of the uses of gas during the last two years for the production of munitions is anything like complete. Some of the more familiar have been omitted owing to exigencies of time, while it is certain that very many applications of gas are being practised which have not come within the scope of one's own observation.

The extent of the increase in the use of gas for industrial purposes during the past two years can be best demonstrated by the consumption recorded by the gasworks in industrial towns. By the kindness of the respective gas engineers I have been furnished with the remarkable figures given on page 413 showing the consumption for the last complete year of peace and for the year ended December 31st last.

Gas Consumption for Manufacturing and Power Purposes in Eight Industrial Towns.

	District.	Annual Consumption for Industrial Purposes. 1913.	Annual Consumption for Industrial Purposes. 1916.	Percentage Increase.
		Cubic ft.	Cubic ft.	
A	Midlands	110,707,000	174,167,000	57
B	,,	327,047,700	420,490,600	28
C	Yorkshire	10,760,800	21,583,700	100
D	North-East	187,473,300	321,841,800	72
E	,,	650,000,000	1,650,000,000	154
*F	Midlands	1,901,392,000	3,500,000,000	84
*G	,,	65,882,200	140,000,000	112
*H	North	720,032,300	1,155,461,810	64

* These figures are to March, 1913, and (estimated) to March, 1917, in each case.

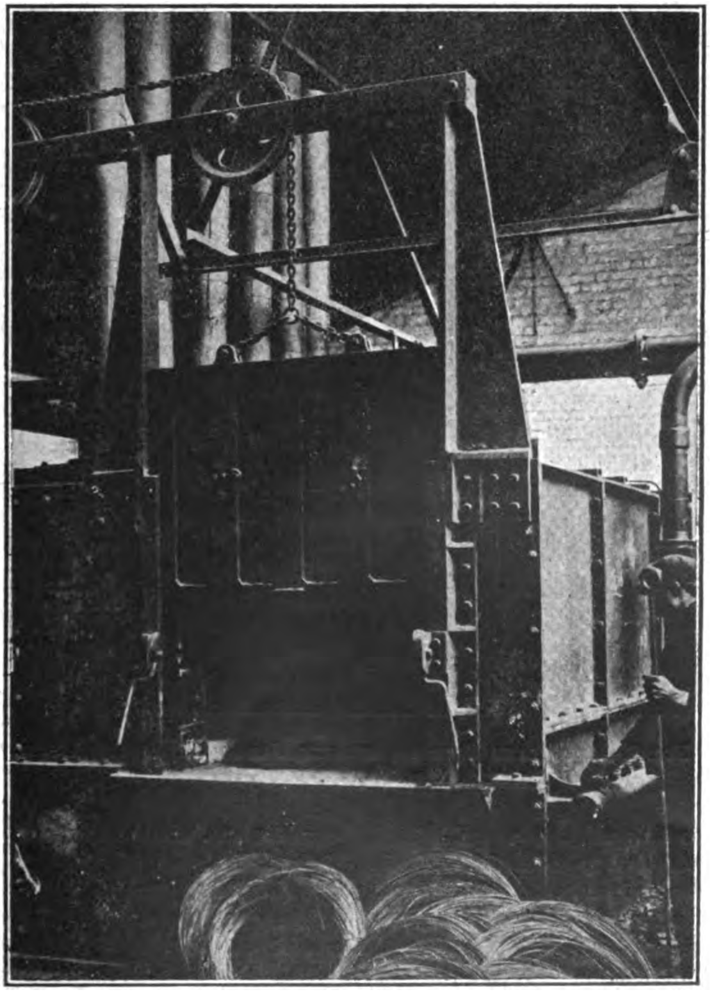

Fig. 8.—Annealing Wire in Gas-oven Furnace.

Coming to individual factories, by the courtesy of the Engineer of one of the largest gasworks in suburban London, I am able to give the following figures of consumption, and the increases cannot fail to arrest attention :—

Gas Consumption of Nine Typical Factories on War Work.

	1913.	1916.	Percentage Increase.
A	3,618,300	15,579,000	330
B	3,631,400	19,407,200	434
C	5,202,800	9,845,100	89
D	4,944,900	14,836,900	200
E	1,187,600	40,546,000	3,314
F	818,500	8,314,900	923
G	23,390,400	52,043,500	122
*H	—	111,407,200	—
*I	—	40,000,000	—

Welfare Work in Factories.

In the period of reconstruction and readjustment that will follow the war many problems will call for solution. Numerous views have already been expressed. Books, almost without number, have been published, and almost every day brings a fresh contribution. It would not be relevant to say anything on the subject today, except in respect of two points on which I think we shall all be agreed—viz., the desirability of improved relations between Capital and Labour, and the supreme need in the country's interest for continuing the high level of productivity which the last two years have witnessed.

One of the outstanding and most remarkable features of this generative time has been the extraordinary growth of what is known as "Welfare Work" in factories. Such marvellous success has attended its expansion that there is no doubt of its substantial contribution to the solution of the two problems I have mentioned.

The Ministry of Munitions, under the inspiration of Mr. Lloyd George, early recognised its value, and appointed a special committee "to

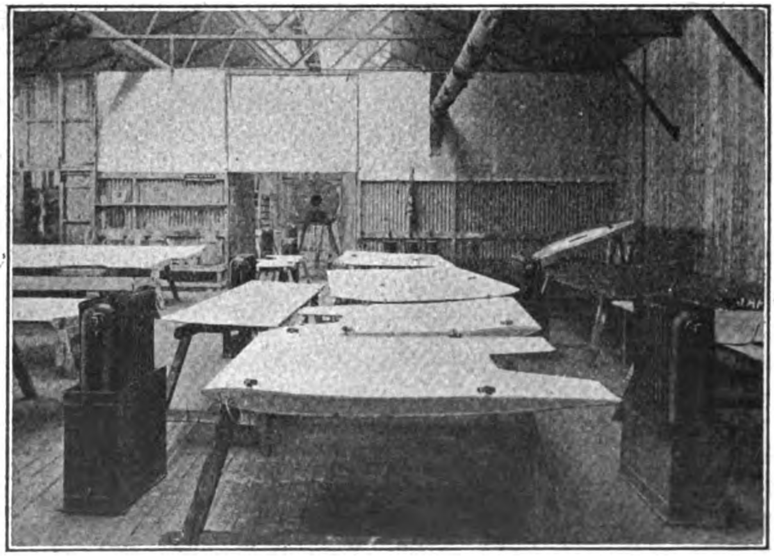

Fig. 9.—Aeroplane Factory, showing Gas-steam Radiators for maintaining High Temperatures.

Fascinating as this subject is, and full of interest to all who love to mark the stages in the development of industries, I must not linger, as I wish to call attention to other and equally important uses of gas in industry.

consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops."

This committee has issued memoranda, to the number of fourteen, of a most practical

* New factories, recently opened.

character; and every possible kind of guidance and assistance has been provided for employers who desire to improve the working conditions of their men and women, and to secure their highest efficiency, and consequently their full productivity, for the nation's need. Arising out of the recommendations of this committee, and recognising the need for co-ordinating and directing the beneficent intentions of employers, an important adjunct to the Ministry of Munitions is now a Welfare Department, controlled until recently by that eminent sociologist, Mr. B. Seebohm Rowntree, who is now succeeded by Dr. E. L. Collis. It is of good augury for the future that the largest employer in the land—the Ministry of Munitions—thus recognises its responsibility for the welfare of its workers. May I quote the Prime Minister's own words?

"I cannot insist too strongly on the importance of this movement. It helps to secure a larger and speedier output of munitions; it preserves the health and the happiness of the workers; it relieves the harassed employer of needless strain.

"It is a strange irony, but no small compensation, that the making of weapons of destruction should afford the occasion to humanise industry. Yet such is the case. Old prejudices have vanished, new ideas are abroad. Employers and workers, the public and the State, are all favourable to new methods. The opportunity must not now be allowed to slip. It may well be that, when the tumult of war is a distant echo, and the making of munitions a nightmare of the past, the efforts now being made to soften asperities, to secure the welfare of the workers, and to build a bridge of sympathy and understanding between employer and employed, will have left behind results of permanent and enduring value to the workers, to the nation, and to mankind at large."

Welfare work is not altogether a new thing in this country nor in America. Successful attempts, some on a scale as elaborate as the best we know to-day, were made many years ago; but it is only recently that it has attained great prominence.

Its benefits to the employer were seen to be as pronounced as to the employee. Care for the health and well-being of the worker created a greater productivity, and enabled the enhanced output to be maintained over a period of almost unlimited extent.

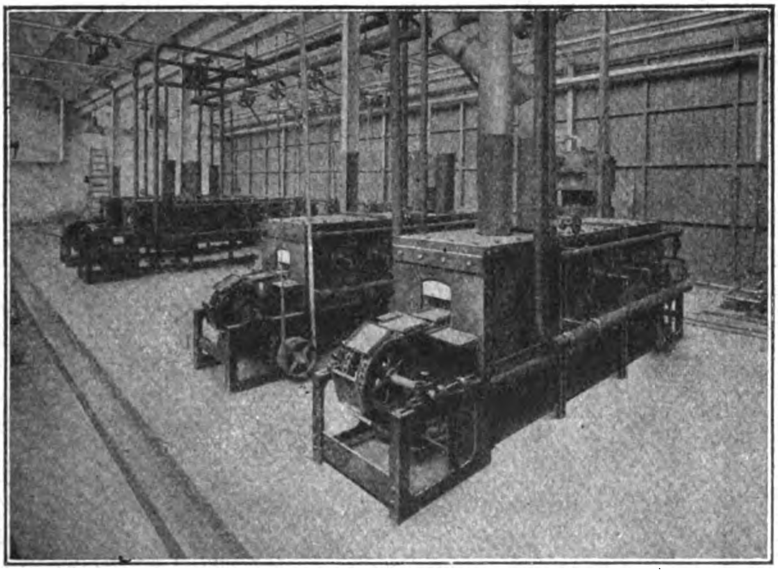

FIG. 10.—FOUR BELT-DRIVEN CONVEYOR FURNACES FOR HEATING BRASS BILLETS.

The definition of welfare work given by Miss Dorothea Proud in her recent book is:—

"Welfare work consists of voluntary efforts on the part of employers to improve, within the existing industrial system, the conditions of employment in their own factories."

Numerous, indeed, are the measures which fall within the scope of this definition, and probably no one factory can yet be found which has embraced them all. It includes a carefully designed factory, with adjacent open spaces given to gardens or recreation grounds; good ventilation, heating, drainage and lighting.

Walls and floors and machinery have to be considered as rendering possible a constant state of cleanliness; due regard has to be had to the number of work-people per room or shop; machines have to be effectively guarded against accidents; provisions have to be made for first aid and for ample escape in case of fire; lavatories and sanitary appliances should be commodious and readily accessible. Swimming-baths and gymnasia come within the wide limits question, and that of the daily transport of the workers from their homes to the works. Still wider fields for welfare work are to be found in "after school" education of boys and girls over the school-age limit; the technical education of young employees, with the consequent regulation of their hours of work; provision for mental development of employees by the institution of libraries, reading clubs, bands, singing classes, etc.

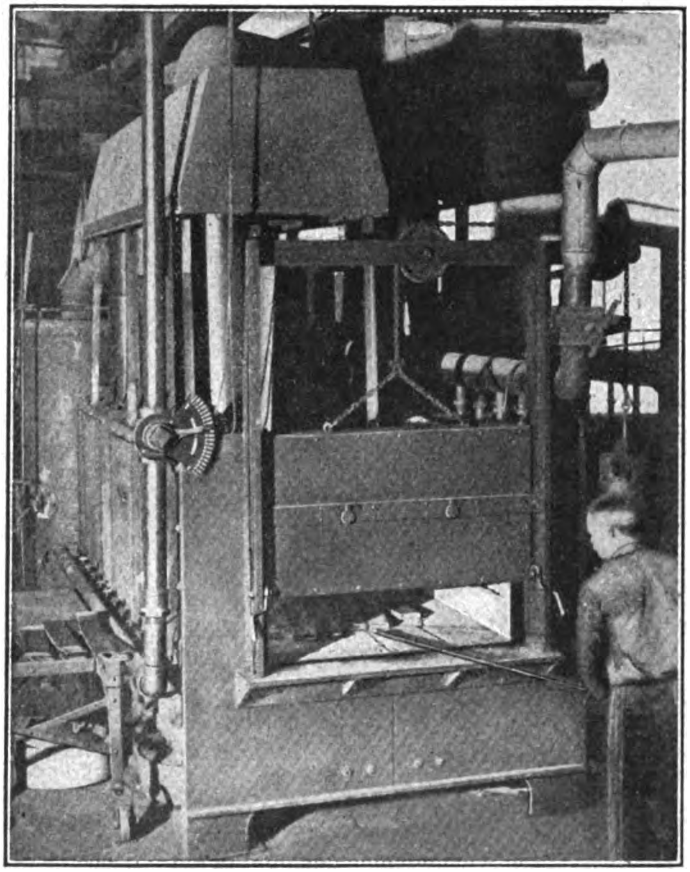

FIG. 11.—OVEN FURNACE FOR ANNEALING CUPRO-NICKEL.

of this new principle in industrial organisation; while, most important of all, there is the dining-room with its kitchen. Then there is the health of the workers to receive consideration; and doctors, nurses, and dentists are employed. Arrangements are made for the reception of employees in convalescent homes and holiday homes. Facilities are provided for and encouragement given to the workers' recreations and hobbies, both outdoor and indoor. Still within the definition of welfare work come the housing

THE INDUSTRIAL CANTEEN.

With many of these things we are to-day concerned in our consideration of the national importance of gas in war time; and probably ranking primarily in importance and pivotal to all the other schemes is the question of feeding the worker. This introduces the industrial canteen.

To quote one of the memoranda issued by the "Health of Munition Workers Committee" previously referred to:—

"There is now an overwhelming body of experi-

ence which proves that productive output in regard to quality, amount, and speed is largely dependent upon the physical efficiency and health of the worker. In its turn such physical fitness is dependent upon nutrition."

Ordinarily there are many obstacles to workers securing this adequate nutrition. Many, probably most, workers must have their meals away from home; many have to work on night shifts. The common method formerly in vogue was for the worker to bring from home food prepared for eating. This necessarily limited the choice of food; it was cold, and likely to be stale. When the weather was warm or the workshop hot it readily underwent deterioration. An advance on this crude plan was for the employer

The first Minister of Munitions realised that the development of canteen provision on a large scale at numerous munition works would require the encouragement, guidance, and assistance which only a Government Department could afford. At his request the duty was undertaken by the Canteen Committee of the Central Control Board (Liquor Traffic), who have set up the necessary machinery for advising employers as to the design, equipment, and management of canteens. Arrangements have been made by which in certain cases controlled employers are enabled, with the approval of the Committee, to meet the capital cost of canteens from profits which would otherwise have accrued to the State under the Munitions of War Act, 1915.

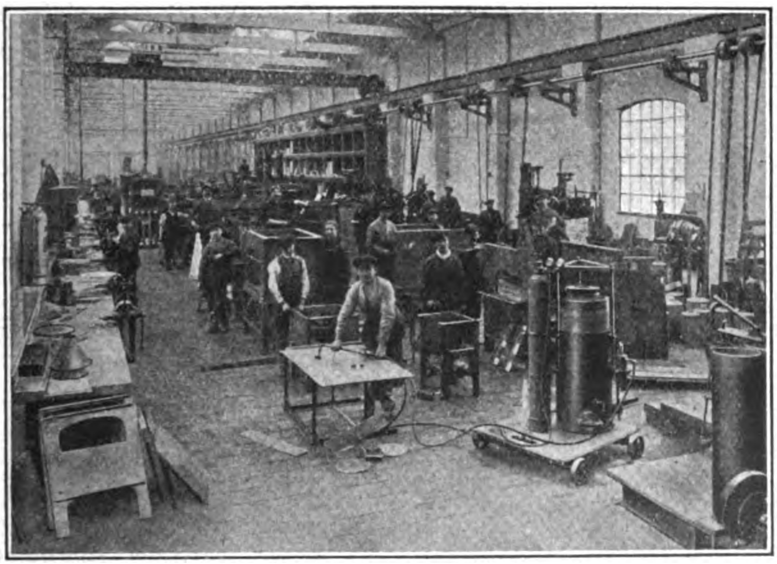

FIG. 12.—PART OF THE RICHMOND GAS STOVE AND METER COMPANY'S FURNACE-ERECTING SHOP AT WARRINGTON.

to provide facilities for warming up food brought from home. In some districts, of course, public-houses and dining-rooms are available outside the works. But even in these cases the accommodation is not always adequate, and frequently the conditions are far from satisfactory. To meet the problem, therefore, employers have established work-peoples dining-rooms or industrial canteens in or near the factory itself. The Health of Munition Workers Committee states:—

"This practice has abundantly justified itself from a business and commercial point of view; and in the opinion of the Committee the time has come for a large extension of this method."

Canteens, as in other forms of welfare work, naturally range from the simple provision of a separate room in which the workers may eat their own food to an elaborate scheme of a complete dining-room. We are chiefly concerned to-day with the kitchen, the equipment of which with the most suitable apparatus is a matter of utmost importance.

Food must be well cooked or complaints will naturally soon be voiced. The cooking must economise and not waste the food, since the most stringent care is necessary to secure the utmost value owing to the comparatively low prices that must be charged, and particularly now that our food supplies are so costly and

need to be so carefully conserved. The cost for fuel must be as low as possible; and the whole work must be performed with a minimum of labour. It was doubtless these considerations that led the Committee on the Health of Munition Workers to state: "Where gas in sufficient quantity is available, gas cooking is usually preferred on account of cleanliness, efficiency, and saving of labour."

Examples of Canteens.

We will commence our illustrations with two examples of modest installations for supplying meals in small factories. The first slide shows a works kitchen providing meals for about sixty hands. This is quite a simple equipment, but adequate for the requirements, and doubtless a great boon to the workers. The installation illustrated in the next slide is a little more elaborate and caters for about one hundred workers daily. Still on the ascending scale, our next view is of a kitchen for about 250 people. Here the apparatus is naturally much larger and more varied. This kitchen provides meals for a department of one of the largest firms engaged in the motor industry, as to which it may be said that hardly any industry has done greater and better work for the country in these times. Our next slide shows the dining-hall. A factory of this magnitude would have several canteens, each to cater for a different department.

The next slide gives us a good idea of a slightly larger kitchen for 350 hands. The service counter can be seen and, on the right-hand side, a corner of the mess-room.

Now I want to show you several views of the kitchen and dining-room of one of our largest manufacturers engaged on war work. This canteen is so well equipped, so excellently managed, so thoroughly patronised, and has produced such eminently satisfactory results, that it deserves a rather longer description.

The accommodation of the canteen is for 600 persons. The kitchen, as will be seen, has gas apparatus installed throughout, and the next slide shows another view, with gas-heated circulators, for supplying hot water (Figs. 14 and 15). This equipment provides daily: (*a*) Early tea and hot milk for night staff of 500 workers; (*b*) breakfast at 8 a.m. for 450 workers; (*c*) complete dinners at 11.45 a.m. and 1 p.m. for about 400 workers at each sitting; (*d*) teas for workers who come to the canteen; (*e*) over 120 complete teas sent out in batches to workers in different parts of the building; (*f*) suppers for night workers.

The next slide (Fig. 16) is a general view of the dining-room at one o'clock. The method of serving the principal meal of the day—dinner—may be briefly described. On entering the building the workers purchase from the pay desk vouchers or checks—one for meat and vegetables and one (of different colour) for sweets. The checks are handed in by the workers at the

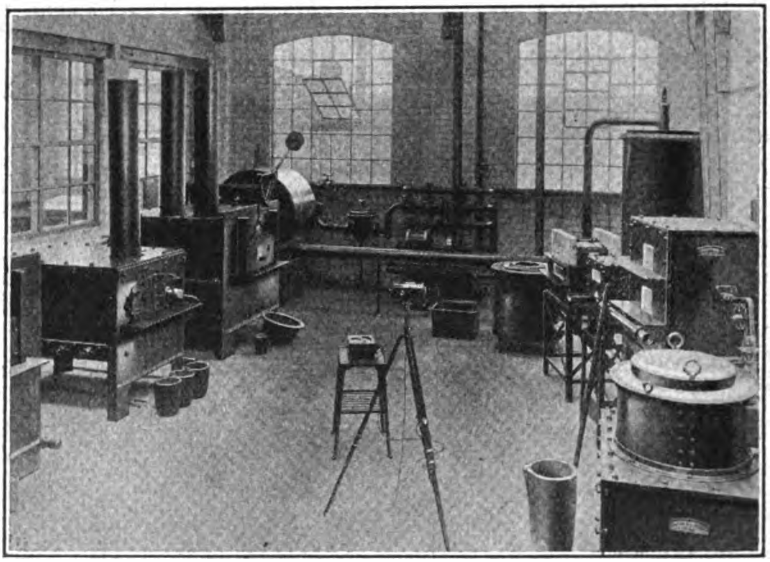

Fig. 13.—Corner of Furnace Test and Demonstration Room.

serving counter. No money is taken here, and the worker has only to indicate his preference for the different dishes on the menu. About two-thirds of the estimated requirements of portions of meat are carved beforehand, and placed in hot closets seen in the first picture. Vegetables, sweets, etc., are all dished up and placed at hand in convenient positions. By these means the whole 400 workers are served within ten minutes of entering the building. The next slide shows the dining-room at 1.10 p.m. (Fig. 17). The workers carry their own food to the tables, picking up forks, knives and spoons from a table in a central position.

The tables are two feet wide, solidly constructed, the tops being covered with white American cloth. The chairs are 15 in. wide, and about 20 in. is allowed at table for each person. The women workers have their dinner at 11.45 and the men at one o'clock, these times leaving sufficient interval for clearing up between the two sittings. The staff consists of a lady superintendent, two cooks, two assistant cooks, six waitresses to serve at counter, scullery maids for washing up, etc. A small stall is provided (seen on the right of the picture) for the sale of cakes, buns, sweets, tobacco, etc. The artificial lighting is by incandescent gas burners throughout and the heating by gas-steam radiators, one or two of which can perhaps be discerned at the extreme left-hand side of the picture. An example of one day's menu with prices may be of interest:—

TYPICAL MENU AT LARGE WORKS CANTEEN.

Monday.	
Roast Beef or Roast Mutton, Onion Sauce Beans, Potatoes	9*d.* and 7*d.*
Sago Pudding or Fig Pudding	2*d.*
Tuesday.	
Bean Soup (with bread)	3*d.*
Hot Pot	6*d.*
Sultana Pudding or Prunes and Custard	2*d.*
Wednesday.	
Roast Beef or Roast Pork, Apple Sauce Peas and Haricots	10*d.* and 8*d.*
Rice Pudding or Currant Roll	2*d.*

FIG. 14.—KITCHEN FOR PROVIDING MEALS FOR 600 EMPLOYEES.

I may add I have submitted this menu to the Ministry of Food, who express their approval of it, with the exception that the puddings should be made of maize or barley meal.

At these prices the canteen, by careful management and scrupulous attention to detail, is self-supporting, the cost of the building and equipment having been borne by the firm. A corresponding canteen, not quite so large, catering for about 300, and installed at another of the works of the same firm, is seen in our next slide. The view is of the dining-room, and the prevail-

ing airiness, lightness, and aspect of comfort will be noted.

The next picture (Fig. 18) is of the exterior of a canteen. This company has endeavoured to study the comforts of their employees in a great variety of ways, and the photograph, taken from the bowling-green, is some evidence of their consideration. The interior of the splendidly fitted kitchen provides our next picture.

The measure of the value of a canteen is the extent to which it is patronised by the workers, and this slide shows us part of the dining-room of a factory, filled to its utmost capacity. Two thousand work-people take their meals here daily. The next picture is of another large dining-room, and proves there is no doubt as to its popularity among these work-girls (Fig. 19). I have referred previously to the usual method of serving meals, and the slide now shows a service counter—the girls collecting their own dinners and carrying to the tables.

The provision of ample supplies of hot water is essential for good working. You probably noticed the gas-heated circulators on the screen just now, and this is a nearer view of another battery which provides hot water for a large number of taps. The gas consumption is automatically controlled, so ensuring great economy in use.

The arrangement of the apparatus in the kitchen is of immense importance. The next slide (Fig. 20) gives a ground-floor plan of a kitchen for providing for approximately 850 hands. The apparatus must not only be well-designed, but so situated that both in preparation and in serving there is no waste of time, and no impeding of one operation by another. "Speed" and "economy of labour" are great watchwords in industrial canteen work.

The next slide (Fig. 21) shows a staff dining-room of one of the large Government offices. The expansion of women labour in Government Departments has emphasised the need for this provision.

The last pictures on this topic are of a very elaborately-equipped canteen at the works of a large firm near London. This is a general view of the kitchen (Fig. 22), which is centrally placed in the dining-room, serving dinners for about 1,000 workers. An additional 500 employees bring their own food to be warmed up. The next illustration gives a closer view of the kitchen; and some of the large and massive gas apparatus can be seen.

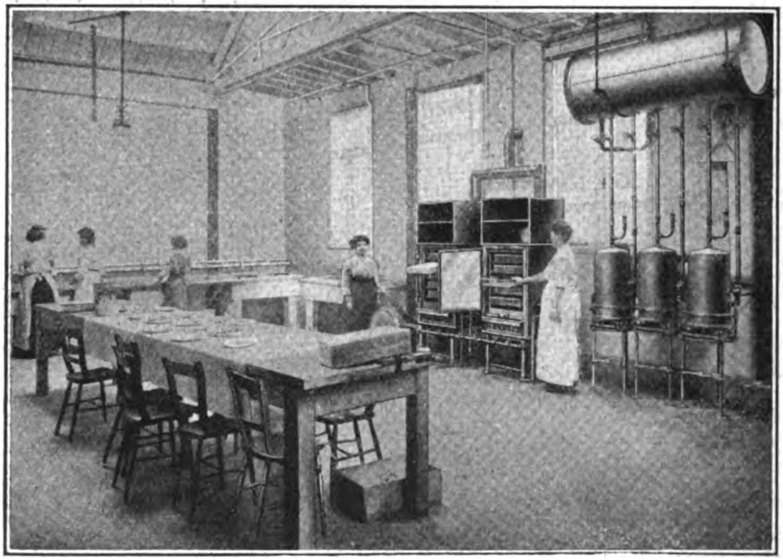

FIG. 15.—ANOTHER VIEW OF KITCHEN, PREVIOUSLY SHOWN, PROVIDING MEALS FOR 600 EMPLOYEES.

GAS APPARATUS FOR TEA AND COFFEE-MAKING.

The provision of tea, coffee and cocoa for workers is sometimes associated with, and sometimes separated from, the general canteen work. Also in factories where, for various reasons, it has been decided not to instal a complete canteen, it will be found a general practice to supply at least tea, cocoa, hot milk, etc. This is highly appreciated by the workers—especially

by female employees, of which the number has so enormously increased—and conduces in a high degree to maintaining general efficiency. The Health of Munition Workers Committee strongly recommend the practice, and in works carrying on certain industrial processes entailing special risk of disease the Ministry of Munitions stipulate that this provision shall be made. The picture now before you shows a large gas apparatus for providing instantaneous supplies of boiling water in one factory. The large storage cylinder combined with a powerful boiler enables 500 pots of tea to be made in a few minutes. The next slide is another type of boiler more suitable for supplying intermittent requirements.

The result secured by, and the advantages accruing to, both employers and workers following the establishment of factory canteens have been very impressive. They are summarised as follows by the Canteen Committee of the Central Control Board:—

Direct Benefits.—(1) Marked improvement in health of workers. (2) Less sickness. (3) Less absence and broken time. (4) Less tendency to alcoholism. (5) Increased efficiency in output.

Indirect Benefits.—(1) Saving time of worker. (2) Salutary change from workshop. (3) Greater contentment of worker. (4) Better mid-day ventilation of workshop. (5) Increased recreation and games in spare time.

The photograph now on the screen is evidence of the trend of the times. It is of a poster to be seen now on the walls of a northern factory, and you will observe the provision of dinner facilities is one of the inducements held out to secure employees.

The opinion of employers who have had experience of canteens on a large scale is markedly favourable. The Chief Factory Inspector says:—

"It is gradually being recognised that the physical fitness of the worker has an important bearing on the output of the factory, and so it is to be found that dining-rooms and restaurants are slowly becoming more general, more especially in the modern and most up-to-date factories, and in those so situated that the workers cannot return home readily for their meals."

He adds:—

"The experience of a Bristol firm is most instructive on this point. They have no less than five restaurants in one group of factories, each large enough to accommodate 1,000 people, and the meals are provided by the employers at cost price or slightly below it. The first restaurant was started five years ago for one department only, and it was observed that a gradual reduction in the sickness rate in that department followed, until eventually it fell to one half the amount experienced previously, when the bulk of the workers had not the opportunity of obtaining a good mid-day meal. Similar results were experienced when the restaurants were extended to other departments."

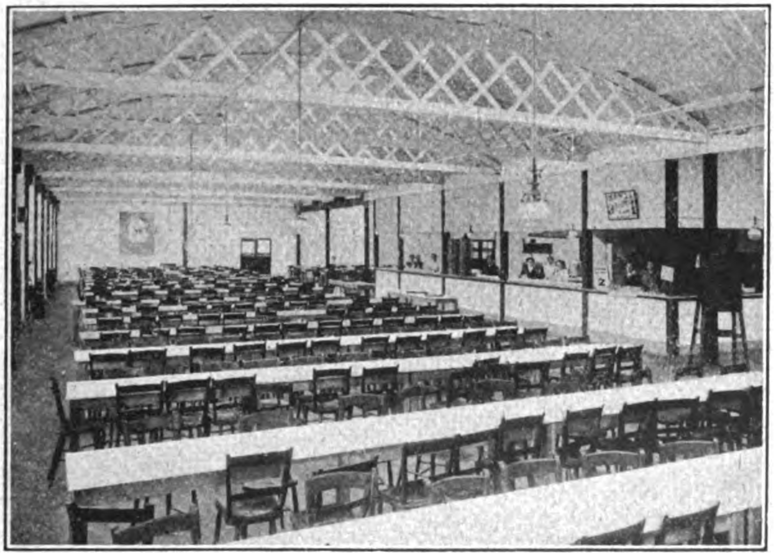

FIG. 16.—DINING-ROOM AT LARGE WORKS AT 1 P.M.

We may well conclude this brief account of a movement possessing wonderful potentialities by another quotation from Mr. Lloyd George:—

"I am delighted to see these canteens springing up throughout our workshops. They make an

enormous difference. That men should get their meals, not in the old, squalid, uncomfortable conditions, but in conditions which are in themselves attractive and healthful, is better for the working-man and for those who are in charge. It is better for all, and certainly better for the State. We are making a better country because we have the recognition that the interests of one section of us are the interests of all."

I should like to have continued and told you of the uses of gas in many other departments of welfare work—such, for example, as the important subject of good illumination, which is adequately provided by the use of incandescent gas burners; and of the provision of washing facilities and baths where gas-heated circulators provide the necessary supplies; and of the rest-room heated by the hygienic gas fire; and of the first aid post, with its gas-heated geyser for hot water, etc. Time, however prohibits detailed references to these subjects.

These, then, are some of the ways—representative of numberless others—in which gas has served the community in war time, and I am sure you will agree with me it is no mean record that it has produced. And yet the story is not complete.

The National Importance of the By-products.

Apart from its importance as a lighting, heating and cooking fuel, as I have endeavoured to describe to-day, gas possesses other and not less valuable properties of great worth in peace times, but essential in time of war. I refer, of course, to the by-products—coke, tar, sulphate of ammonia, creosote, carbolic and cresylic acids, benzene and toluene, certain of which contribute to the making of explosives, such as trinitrotoluol. Of these last, which in this war are vital to our preservation as a nation, the gas industry is providing a worthy proportion of the output in this country. Reluctantly, I must withhold the actual figures; but the full story of the patriotic endeavours of the gas undertakings in their ready response to the request of the High Explosives Supplies Department at the Ministry of Munitions will be told one day when the war is over.

Further, there has to be considered the conservation of one of our greatest assets, our stock of unmined coal. Professor Brame, the successor of Professor V. B. Lewes in the Chair of Chemistry at the Royal Naval College, Greenwich, estimates the coal reserves as follows:—

	Millions of tons.
United Kingdom	186,153
Germany	415,794
Russia	59,079
France	16,207
Belgium	10,808

He further deduces, from our present rate of coal production, that we are exhausting our supplies at a far higher rate, proportionate to our stock, than our nearest commercial rivals. The Royal Commission on Coal as far back as

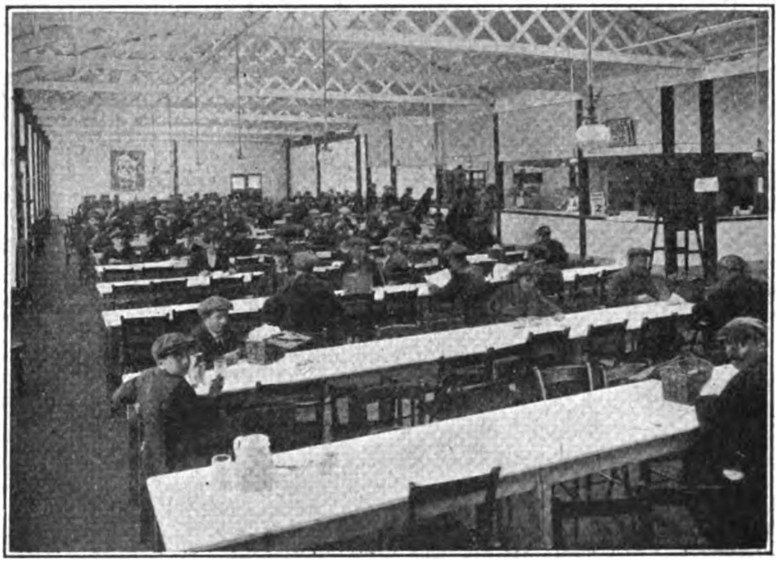

Fig. 17.—View of Dining-room, previously shown, at 1.10 p.m.

1871 contemplated the time when we, whose industrial greatness has largely been founded on our abundant and easily-obtained coal supplies, shall actually have become importers of coal. The statistics issued by the International Geological Congress in 1913 revealed that Great Britain only possesses about one-fortieth and our whole Empire only one-fourth of the world's estimated coal reserves; while the United States, likely to be our chief competitor in the near future, holds more than half. The most economical use of our remaining supplies is, therefore, a very practical and urgent question, and to aid in the solution the gas industry offers an important contribution, and we welcome the formation of the Board of Fuel Research, appointed by a Committee of the Privy Council, and presided over by our Chairman of to-day, Sir G. T. Beilby, LL.D., F.R.S.

We are chiefly concerned to-day with the fuel consumption of the factories of the country. It has been estimated that some 70 million tons of coal are burnt per annum for industrial purposes. Now I do not suggest that the whole of this coal could be displaced by gas; but a large part of it undoubtedly could be. With what result? First, this huge total of coal consumed in factories, if carbonised in the retorts of gas-works, might be expected to produce about 840,000 million cubic ft. of gas; and, as I have endeavoured to show, this immense volume of thermal energy utilised for industrial heating processes would produce much enhanced results compared with those to be obtained if the coal were burnt crudely.

With coal there is a large amount of waste of heat units in effecting its combustion, and in driving off those volatile constituents which are useless where high temperatures and pure incandescence are required and must be obtained. There is also waste of heat units up the chimney shaft and through stand-by requirements. There is waste of heat units every time a fire is recharged until once more favourable working conditions of the fire are realised.

The Value of the By-products.

Then we come to the by-products, and the picture strikingly demonstrates their variety and their number. Instead of these ascending the chimney and "wasting their foulness on the city air," if scientifically treated on the lines of modern practice, they are preserved for the service of man. The coal burnt annually in our factories, would, if carbonised, give us, in addition to the thermal value of the immense volume of gas mentioned, say, 35 million tons of a smokeless fuel—coke—of high calorific value, and suitable for innumerable uses. Since the war started a large advance has been made in its application to steam-raising in road traction.

Then the amount of coal mentioned would give approximately 700 million gallons of tar, the worth of which will be obvious. One of its many uses, of recent development, is for road-making; and the new roads in the military

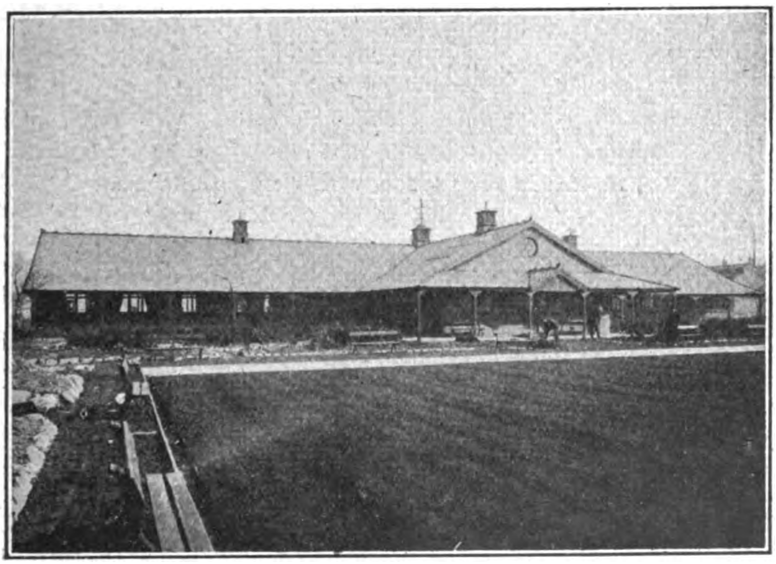

Fig. 18.—Exterior of Industrial Canteen for 500 Hands.

areas in France have used thousands upon thousands of barrels of tar from English gas-works. As one of its minor uses, I might mention that I was told recently that tar was the most suitable lubricant for steel-pressing work. The contact with the hot steel split the tar into its free oils, and it was giving great satisfaction, and was considerably cheaper than other lubricants.

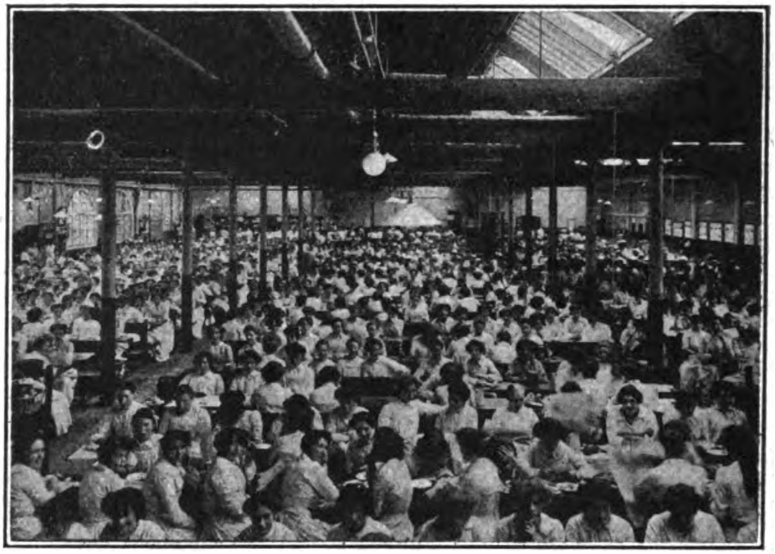

FIG. 19.—LARGE DINING-ROOM, WITH WOMEN AT DINNER.

Another valuable by-product of gas manufacture is sulphate of ammonia. From the 70 million tons of coal before referred to might

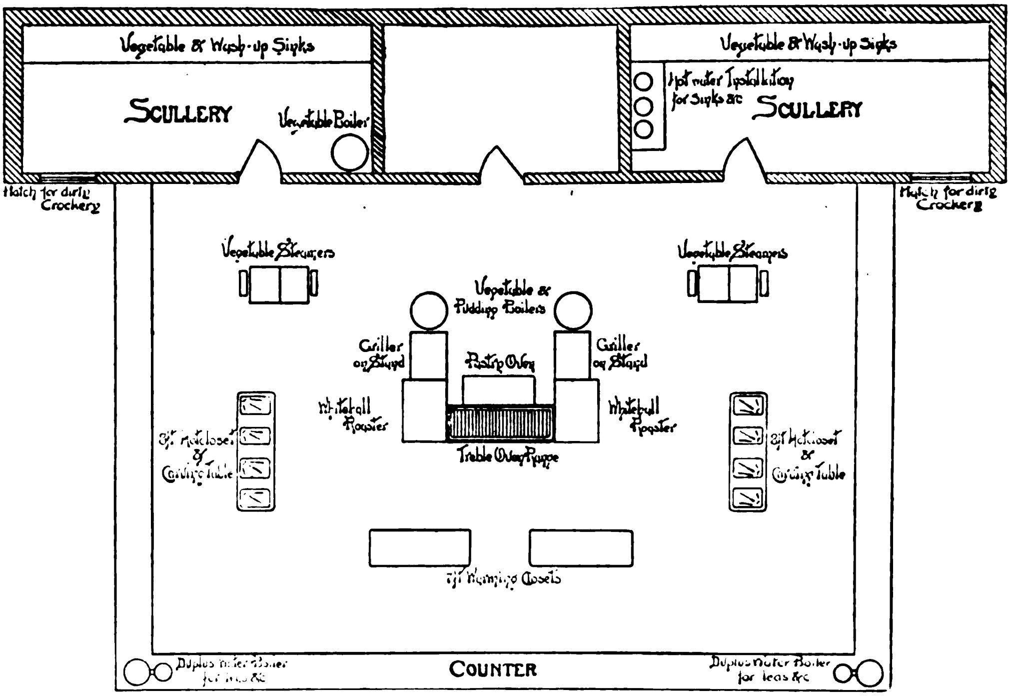

FIG. 20.—GROUND-FLOOR PLAN OF WORKS KITCHEN, SHOWING ARRANGEMENT OF APPARATUS FOR PROVIDING FOR (APPROXIMATELY) 850 HANDS.

be extracted about 825,000 tons of this excellent fertiliser. Its worth has been emphasised by the Board of Agriculture in its endeavours to cultivate home production of foods.

The increase in motor traffic and the consequent passing of the horse have largely deprived our farmers of a source of material of good manurial value. These are, however, days of intensive cultivation—days when the largest and most valuable product per acre of land is required, and artificial fertilisers are therefore more than ever increasingly necessary. Nitrate of soda is a valuable fertiliser in respect primarily of its quick action under favourable conditions, but with heavy rains it suffers the disadvantage that it is quickly washed out of the soil. It is imported, and it therefore helps to weigh in the balance against our exports. Sulphate of ammonia is in normal times cheaper per unit of nitrogen than nitrate of soda, and much more so now. To destroy such a rich fertiliser by the crude use of coal is emphatically not to the national advantage.

I have already referred briefly to the explosives derived from coal tar, to the motor spirit (benzol) that is recovered and of which it is estimated over 200 million gallons are lost per annum through the consumption of raw coal in our factories. I might continue and remind you of the dye, drug, chemical, photographic and perfume industries dependent on the derivatives of coal-tar distillation.

Possibilities for the Future.

An absorbing story, truly, is this wonderful recovery of such priceless commodities from the secondary products of coal-gas manufacture. What an impetus it provides for legislation to reduce the amount of coal burned in a raw state! So vast are the possibilities that it is quite within the range of reason that gas may become the by-product and the present by-products the primary ones. The value of the products for which coal would be carbonised and tar distilled may, with the revelations of time and science, become so great as to enable the gas to be sold at an exceptionally low figure—so low that competition of any other fuel, including raw coal, would be impossible. The present position is that less than one-fifth of the coal extracted from our mines is treated for the recovery of by-products. This gives an idea of the field still awaiting investigation and development.

In addition to the direct loss in the by-products, which I have tried to explain, there is the loss to the nation by the employment of the labour, horse and other vehicles necessary for the distribution of coal, which, of course, contributes to the wear and tear of our roads. All of this will be detrimental to our productive capacity in the strenuous years ahead; and, therefore, the transfer of every possible pound of the crudely-used coal to a more scientific and economic usage is an imperative necessity.

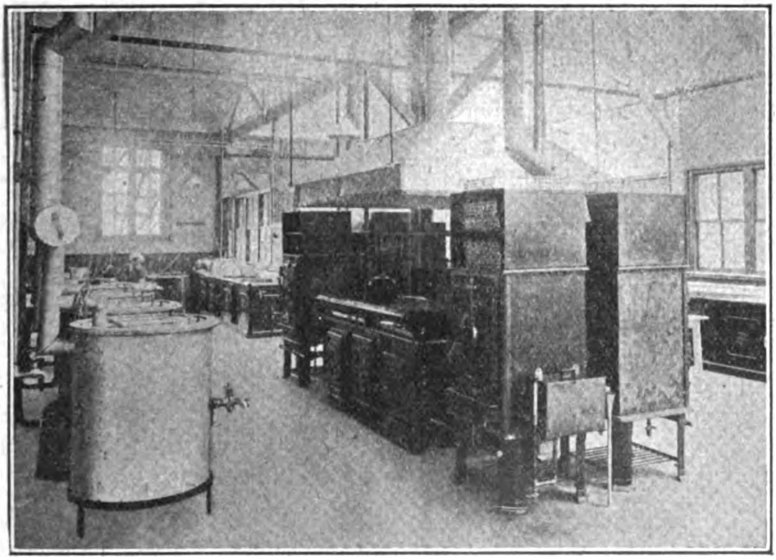

Fig. 21.—Staff Kitchen in a Government Department, equipped with Richmond Apparatus.

So far, I have to-day again endeavoured to tell some part of the story of the service of gas in war time, inadequately, I fear, for the colossal nature of the subject renders it impossible for one individual to deal fully and justly with the whole. But if I may assume for the moment the *rôle* of prophet, and you ask me as to the prospects of the future, I can only reply that in my considered judgment what has already been accomplished is but a small earnest of what may be expected. The great market for gas seems to me to stretch almost illimitably into every sphere of human life and activity. New functions for its use and new methods of application are being discovered daily, appliances for its consumption are being perfected and mechanical handicaps are being removed, and its supremacy above all fuels is being gradually but surely recognised.

In the realm of domestic cooking, heating, and water-heating its sway is becoming universal. Possessing the advantages we have seen this afternoon, with its record of service in the hour of the nation's greatest need—with the knowledge of its value gained in a time of unprecedented stress and strain—can we doubt that in time, shorter in period perhaps than is at present apparent, gas will be equally supreme in the greater world of industry?

In conclusion, I would express my thanks to many engineering friends who have responded to my request for information on the subjects treated in this paper, and to the Richmond Gas Stove and Meter Company, Ltd., Warrington, for providing details of their gas furnaces.

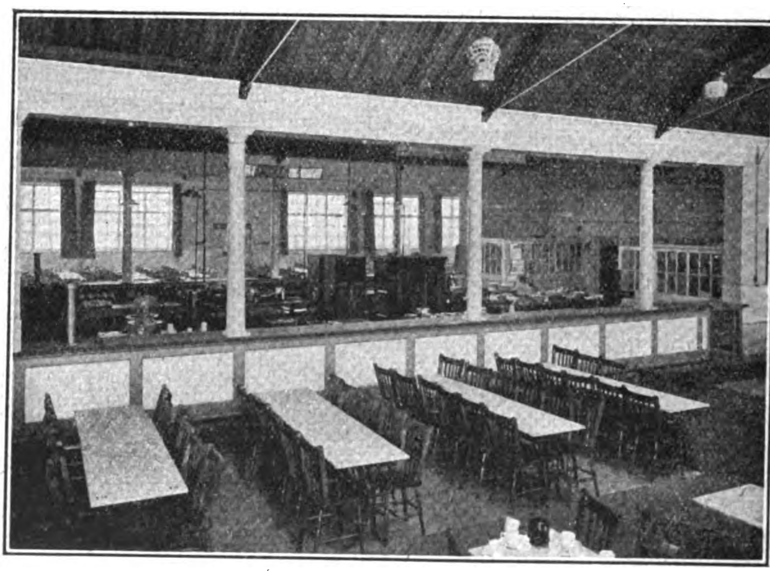

FIG. 22.—WORKS KITCHEN SERVING MEALS FOR 1,000 EMPLOYEES.

DISCUSSION.

THE CHAIRMAN (Sir George Beilby, LL.D., F.R.S.), in opening the discussion, thought the last part of the paper had not only partaken of the character of prophecy but of the character to some extent of the remarks of certain lecturers and professors, who stated that the country's resources were being wasted in a hopeless way, but that it was only necessary to wave a magic wand to produce great wealth and prosperity for the nation out of those wasted products. But for the first part of the paper he might have made some criticisms upon that attitude. The lesson, however, he was inclined to draw from the paper as a whole was that those great reforms could only be brought about by the kind of work that the author and his colleagues had been patiently and diligently doing for many years past. Had it not been for the author and others who, before the war, were quietly developing the use of coal gas in many remarkable ways, there would have been no one to supply the munitions and the help that the Army so urgently required at the beginning of the war. None of those reforms could be brought about unless workers patiently tackled the different problems that had to be solved, and did not rest until they had, by scientific foresight, by trial and error, and by careful experimentation, mastered the particular bit of the subject which was set before them. He

deprecated the large and airy promises of the wonderful changes that were to take place after the war, and he was delighted that he could make that criticism in the author's presence without his feeling that it was a reflection upon him, because he said most heartily that if the country possessed a large number of Mr. Thorntons the great reforms which everyone was eager to bring about would come much more quickly than would otherwise be the case. Even five years ago it would have amazed those who were accustomed to the use of coal gas in laboratory burners and small furnaces to be told that, within such a short space of time, furnaces 22 ft. long would be in use for the heating of large steel bars. Even the chemist who believed immensely in his laboratory furnace and blow-pipe would have been absolutely staggered had he been told that it would pay economically to heat tons of steel by coal gas costing something like 2*s.* per 1,000 cubic ft. The work the author had done in that respect gave great promise for the future. If it would pay to use in industrial furnaces coal gas at the high cost at which it must necessarily be produced, much more would it pay if by any means it was possible to bring into use very much larger quantities of fuel in the form of a poorer but very much cheaper fuel gas. That was a possibility the author had not touched upon, because his *métier* had been the development of rich gas consumption in industry. He felt quite sure with Mr. Thornton that the consumption of rich gas would still largely increase, but alongside of that it would be necessary to have a much larger production of cheap, and necessarily poorer, fuel gas.

SIR ROBERT A. HADFIELD, F.R.S., said the author had devoted a great part of his life to the consideration of the use of gas in a way which a few years ago would have been thought impossible. His (Sir Robert's) firm used very large quantities of gas, no less than 500,000,000 cubic ft. per annum being used by them entirely for war work at the present time. They did so because it was an immense help in the present time of war, because by burning gas there were no ashes or cinders to take away; a great amount of labour was set free; and the devices to which the author had referred had largely enabled them to increase their output of munitions. With reference to the question of gaseous fuel, he remembered when visiting Pittsburg many years ago seeing a river of fire. Gas was so plentiful in Pittsburg that the waste natural gas was turned into the river, and the people in Pittsburg were kind enough to set it on fire as an exhibition for the benefit of the visitors. Manufacturers in Pittsburg were able to obtain a gas of perhaps a higher calorific value even than coal gas, and in any large quantity required, at the rate of not more than, he believed, 5*d.* per 1,000 cubic ft.; and that was all the more reason why those concerned with the gas industry in this country should set their shoulders to the wheel and so improve methods that cheaper gas could be obtained. If our American competitors, by making use of what Nature had placed at their disposal, were able to obtain gas at 5*d.* per 1,000 cubic ft. or less on a very large scale, it was quite obvious that the manufacturers of this country ought to get as cheap a supply also. Personally, he thought the gas companies were charging far too high a price for their gas; at any rate, they were paying very nice fat dividends. He was a gas director himself, but nevertheless he thought gas companies ought to try and meet the country's needs to a great extent, and 2*s.* per 1,000 ft. for gas was far too high a price. The cheaper the supply the greater would be the demand, and if the cost of gas was reduced he did not think that in the end the gas companies would be hurt in any way whatever. There was no more delicate alloy in the world than steel, for the heat treatment of which gas was largely employed. If a piece of steel was heated to 729° C. and quenched in water it would not harden, but if the same piece of steel was heated only 3° C. more and quenched a dead hard product was obtained. The importance, therefore, of thorough control over the heat treatment of steel was apparent, and he was delighted the author had brought the point forward, because there was no doubt that by means of gas the temperatures could be controlled very accurately. A mixture of coal gas and air in an ordinary open air furnace was apt to give oxidisation zones, the carbon was eaten away from the surface of the steel, and when it was quenched it would not be hard in that particular part. But by means of even heating much more uniformly hardened products could be obtained. He did not think many people had the least idea how much depended upon the proper hardening of a piece of high carbon steel. As a matter of fact, it made all the difference between success and failure. If a certain part of an aeroplane was not properly hardened it probably meant that the aviator lost his life; therefore any method which enabled those connected with the industry to accomplish heating with certainty and regularity was of the highest possible importance. He desired, in conclusion, to put a question to the author. He did not know whether Mr. Thornton was aware of the fact that Sir Henry Bessemer devoted great attention at one time to the production of a high-pressure melting furnace, but he was sorry to say that nobody had continued the work, although he did not know why. With pressures of something like 80 lb. to 100 lb. per square inch Bessemer thought he had arrived at quite a new domain in the melting of various metals. If someone would take up the study of the proper mixtures of gas and air at very high pressures—not the normal pressures of 5, 10, 15 or 20 lb., but four or five times those amounts—he thought there was a great future for the development of that particular method of heating. He would be glad to know if the author had any experience of work being done in that direction.

Mr. F. W. Goodenough said the remarks that had been made by the previous speakers strengthened him in the belief that coal gas had a great future before it as an industrial as well as a domestic fuel. In the factory, as well as in the home, it was becoming more and more true that, owing to the increased efficiency of the apparatus, the same work could be done by gas at an equal or less cost than by crude coal; and yet after the gas had been used there remained the residue of half the quantity of the crude fuel originally consumed left in the form of coke, together with other valuable by-products. That seemed to point the way to a very great conservation of the resources of the country in the future. Sir Robert Hadfield had referred to the question of the cost of gas. He desired to point out that, so far as the gas industry was concerned, the higher the price the lower the dividend. By the statutes that governed the operation of at any rate all the principal gas undertakings in the country, no gas undertaking could pay an increased dividend until it reduced its price, so that there was every inducement to work in the most economical manner possible. With all due deference to Sir Robert, he thought he was right in saying that the average price of gas in the United States was substantially higher than it was in this country. Dollar gas was quite usual in the cities of the United States. He did not think there could be very much the matter with the price of gas in this country, at any rate in Sheffield, in view of the fact that Sir Robert Hadfield's firm had received, in competition with the shell-makers in the States, an order from the United States for shells to be supplied at some future date. That was a triumph of British industry, on which both Sir Robert Hadfield and the Sheffield United Gas Company were to be congratulated.

Mr. James Swinburne, F.R.S., said that Sir Robert Hadfield had referred to the fact that *5d.* per 1,000 cubic ft. was charged for natural gas in America. Natural gas was much more plentiful in America than in this country, and he remembered being told when in Pittsburg that the natural gas was not sold at so much per 1,000 cubic ft., but that a single factory would rent a 5-in. pipe. Under those circumstances, if this country was to compete with America, it was necessary to reduce the price of gas. He desired to ask, however, whether it was really the fault of the gas companies that gas was at its present price. Gas companies were probably very much hampered by law. It was obvious, for instance, that if one factory was taking millions of cubic feet, and if it had to be supplied at the same rate and bear a share of the general cost of the piping not in proportion to its use, it had to pay far more than the small consumer. Laws of that sort often did a great deal of harm to industry, and it was probable that the gas industry was very much crippled by the law in that respect. In view of the great development in the use of gas that had taken place in this country, he had wondered whether it would not be possible to go still further and make gas furnaces a little more economical. Sir Robert Hadfield had mentioned high pressure as a possible way of bringing that about. A foot of gas with the right amount of air would give a certain amount of heat, no more and no less, if burned properly; high pressure did not result in any more heat being obtained out of it. High-pressure systems were merely means of getting a higher temperature by supplying heat more quickly than it could be carried away. Was it not possible in the same way to go still further in the insulation of gas stoves and ovens? With a perfectly insulated large gas oven quite a small quantity of burning gas, *i.e.* gas and air, combined at a very high temperature, could be supplied, and if the heat could not get out it ought to be possible to heat a ton of iron at a comparatively small cost. In a long furnace in which the articles were carried through gradually, it might be the case that the hot gases heated the hottest part of the metal first, and the less hot met the cool part as it came in, but that could only be done in a furnace in which the articles could be passed through continuously. He would like the author to state whether in his opinion there was an opening for improvement in that way, and, if so, whether it was likely to be successful.

Mr. H. M. Thornton, in reply, after thanking Sir George Beilby for the very kind words he had used in opening the discussion, said that Sir Robert Hadfield had raised the question of the price of gas in this country, but his remarks had been answered by Mr. Goodenough than whom nobody was more competent to defend the gas industry, because there was no one who had done so much for gas progress of late years as that gentleman. Mr. Swinburne had raised a most interesting point in regard to the possibility of making gas furnaces more economical, and Mr. Swinburne might have added any gas apparatus that was at present made. The progress made in that direction in the last few years had been exceedingly great; in fact, the apparatus of ten years ago could not be compared with that made at the present time. There had been a wonderful history of progress in recent years. If it had not been for the war, very much greater strides would have been made in dealing with the question of the economising of fuel than had been possible owing to the reduced staffs available in the laboratories. On the other hand, the war had given a tremendous impetus, not only with regard to the necessities of the present time but also the future; and as soon as it was possible for those engaged in the industry to carry out the necessary experiments he was satisfied that in ten years' time the industry would have progressed at at least as rapid a rate as it had done in the past ten years. He had not any experience of the work

done by Sir Henry Bessemer in regard to the melting furnace, but he was quite satisfied that anything that could be done in regard to melting or any other problem would be dealt with by those engaged in the industry as soon as time permitted. He desired, in conclusion, to express his thanks to the various speakers for the kind remarks they had made.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded to Mr. Thornton for his valuable paper, and the meeting terminated.

NOTES ON BOOKS.

BRITISH JOURNAL PHOTOGRAPHIC ALMANAC, 1917: Edited by George E. Brown. Pp. 779. Greenwood & Co.

It can only be the oldest readers of this well-known and useful book of photographic reference who can recall its appearance in its present modest size. During the peaceful years of the present century it appeared as a portly volume of at least 1,500 pages. The war knocked off a third of its bulk, and now it has shrunk to half its former goodly proportions. We may go back for thirty years before we get as thin a volume as the present one, for the number for 1887, when carefully tested by the calipers, proves to be a little thinner. There is no reason to believe that it has suffered from senile decay and shrunk much since it was issued from the press, and as the advertisements were not treated with their present consideration and continuously numbered with the text, a calculation of the actual number of pages is just a little too laborious for the present critic. However, if its quantity is less, its quality is as good as ever, and the amount of useful information it provides is as large as in previous years. The advertisers are limited to a maximum of sixteen pages a head, and the limitation will probably not cause any very poignant feelings of regret to the readers. The amount of miscellaneous information is cut down, but the really useful information, for which a reader naturally turns to the book, is as copious as of old. Facts, formulæ, processes, tables, etc., are as abundant and as full as ever.

THE DEVELOPMENT OF THE SPELTER INDUSTRY. By Ernest A. Smith, A.R.S.M.

When in March of last year the Peter Le Neve Foster prize was awarded to Mr. J. C. Moulden for his essay on Zinc, the adjudicators reported that a second essay of high merit had been sent in, and on their advice the Council of the Society awarded the author the distinction of Honourable Mention.

This essay, by Mr. E. A. Smith, the Deputy Assay Master of the Assay Office at Sheffield, was read and discussed at a meeting of the Institute of Metals in September last, and is now reprinted from the Institute's *Journal*. Dealing as they do with a common subject, the two essays of necessity cover much the same ground, but the manner of treatment is naturally different, and each contains much useful matter not to be found in the other. Thus they supplement each other in a very useful fashion, and as each is a valuable contribution to metallurgical literature, the two together form a record of enhanced importance. For this reason it is extremely satisfactory that a means has been found for the official publication of Mr. Smith's essay. It is also a well-deserved compliment that his work should receive the recognition of an important society like the Institute of Metals, and this must be specially gratifying to the author, since it indicates the professional as well as the scientific approval of his labour.

GENERAL NOTES.

IMPORTS OF ENGLISH COAL TO ITALY.—*L'Union Franco-Italiano*, a weekly journal published at Nice in the two languages, states that the imports of English coal to Italy last year show a decrease of 3,937,152 tons, or nearly half the total as compared with those of 1913. The quantity of coal exported from England to Italy during the last four years was respectively—

	Tons.		Tons.
1913 .	9,647,160	1915 .	5,738,460
1914 .	8,625,000	1916 .	5,710,008

JAPANESE MERCANTILE MARINE.—According to a recent official report, Japan's mercantile marine consists of 2,170 steamships and 9,187 sailing vessels. The total tonnage of the former is estimated at 1,704,785 tons, and of the latter at 572,403 tons. Ocean-going steamers exceeding 1,000 tons number 448, with a total tonnage of 1,428,212 tons. Ocean-going steamships to the number of thirty-nine, with a total tonnage of 140,236 tons, were launched from shipbuilding yards in Japan in 1916. In addition, there were fifteen vessels, with a total tonnage of 55,991 tons, which were expected to be completed and launched early in the present year.

THE COALFIELDS OF NORTH-WESTERN FRANCE. —Judging from the tone of a recent discussion in the Prussian Diet, the Germans attach great importance to the rich beds of coal and iron in French Lorraine. Of these, the basins of Briey and of Longwy, in the Department of the Meurthe and Moselle, are the most important. The former are situated about thirty miles east of Verdun, near Metz, whilst those of Longwy, further north, are near the Belgian frontier. Some idea of the importance of the coal districts in the Briey district may be formed from the following figures given recently by the *Economiste du Littoral*, a financial paper, published at Nice. From these it appears that the output of the seventeen principal coal-mines in this district was during the two years preceding the war—

1912 . . .	12,532,240	metric tons.
1913 . . .	14,823,740	„ „

showing an increase of 2,291,500 tons in 1913, as compared with that of the previous year. The total quantity of coal raised in this district and sent to Germany, and lost to France, cannot be less than 15 million tons at the present time. It is also probable that the output of iron ore, which previous to the war was very important, has not fallen off, and that the quantity sent to Germany at the present time far exceeds the production of the pre-war years.

THE PANAMA CANAL.—According to the *Panama Canal Record*, the total number of ships which passed through the Canal from its opening on August 15th, 1914, to January 1st, 1917, was 2,780. Their gross tonnage was 13,086,535 tons, and their net tonnage 9,209,503 tons. The total quantity of cargo carried through the Canal was 11,652,405 tons.

CANADIAN FLOUR.—The milling trade of Canada has had a record year. During the twelve months ended August, 1916, says *United Empire*, 8,000,000 barrels of flour were exported, as against less than 5,000,000 barrels in the previous year. There are 3,200 grain elevators at 1,340 stations, including terminals, with a combined capacity of 185,000,000 bushels, whilst in the Prairie Provinces there are more than 3,000 grain elevators at 1,320 stations, with a combined capacity of 106,000,000 bushels.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. :—

APRIL 25.—SIR FRANCIS FOX, M.Inst.C.E., "Flour and Bread." CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, will preside.

MAY 2.—J. C. SHENSTONE, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future." SIR ROBERT ARMSTRONG-JONES, M.D., F.R.C.P., F.R.C.S., will preside.

MAY 9.—PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

MAY 16.—SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m. :—

MAY 17.—A. C. CHATTERJEE, I.C.S. (United Provinces), "The Encouragement of Thrift and Banking in India."

HOWARD LECTURES.

Monday afternoons, at 4 p.m. :—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 23...Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Professor T. B. Wood, "The Nation's Fodder Supply."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Sir Francis Fox, "Geographical Aspects of the Channel Tunnel."

Engineers, Junior Institution of, 39, Victoria-street, S.W., 7.30 p.m. Professor H. T. Davidge, "Some Applications of Radio-activity."

TUESDAY, APRIL 24...Royal Institution, Albemarle-street, W., 3 p.m. Professor C. R. Beazley, "Russian Development. Lecture II.—The Rise of Moscow."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 8 p.m. Mr. F. de Jong, "Ornamental Plastering and Decoration."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Dr. C. A. Swan, "An Hour's Run across Northern Europe."

China Society, Caxton Hall, Westminster, S.W., 8 p.m. Rev. J. Steele, "Chinese Animism."

WEDNESDAY, APRIL 25...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir Francis Fox, "Flour and Bread."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 5.30 p.m. Dr. M. S. Pembrey, "The Restricted Supply of Food: its Relation to Health and Efficiency."

Electrical Engineers, Institution of (Local Sections), The University, Birmingham, 7 p.m. Mr. G. V. Twiss, "High Tension Overhead Transmission Lines."

Philosophical Hall, Leeds, 7 p.m. Mr. C. Vernier "Wayleaves."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Mr. A. E. Morgan, "Currents of English Drama in the Eighteenth Century."

THURSDAY, APRIL 26...Royal Institution, Albemarle-street, W., 3 p.m. Professor H. S. Foxwell, "Industrial Finance after the War. Lecture II.—Its Financial Needs: How they can be met."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. G. V. Twiss, "High Tension Overhead Transmission Lines."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Mr. S. Bylander, "Secondary Stresses in Structural Steel."

Geographical Society, Kensington Gore, W., 5.30 p.m. Mr. G. Philip, "A New Series of Economic Maps."

FRIDAY, APRIL 27...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. P. Waterhouse, "London after the War."

Royal Institution, Albemarle-street, W., 5.30 p.m. Dr. J. D. Grant, "The Organs of Hearing in Relation to War."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Engineers, Junior Institution of, 39, Victoria-street, S.W., 7.30 p.m. Mr. T. A. Watson, "Cartridge Making."

SATURDAY, APRIL 28...Royal Institution, Albemarle-street, W., 3 p.m. Professor G. H. Bryan, "Principles of Aerial Navigation." (Lecture II.)

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FRIDAY, APRIL 27, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

NEXT WEEK.

MONDAY, APRIL 30th, at 4 p.m. (Howard Lecture.) WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Iron Ore Supplies." (Lecture I.)

WEDNESDAY, MAY 2nd, at 4.30 p.m. (Ordinary Meeting.) J. C. SHENSTONE, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future." SIR ROBERT ARMSTRONG-JONES, M.D., F.R.C.P., F.R.C.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 25th, 1917; CAPTAIN CHARLES BATHURST, M.P., Parliamentary Secretary, Ministry of Food, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Aundh, The Chief of (Balasahib Pant Pratinidi) Aundh, District Satara, India.

Bleloch, William Edwin, Hazleyshaw, Albemarle-street, Kensington, Johannesburg, Transvaal, South Africa.

Bux, Hafiz Mahomed, Islamya Hotel, Ajmer, Rajputana, India.

Conlay, W. L., Kuala Lumpur Selangor, Federated Malay States (*vid* Penang).

Gibson, William James, Box 470, Smit-street, Hospital Hill, Johannesburg, Transvaal, South Africa.

Jennings, Hon. James George, M.A., Ranchi, Bihar and Orissa, India.

Mardon, Ernest George, Avonbank, Clifton Down, Bristol.

Sutherland, Alexander, care of C. P. Edwards, General Superintendent, Radio Branch Naval Service, Ottawa, Ontario, Canada.

The following candidates were balloted for and duly elected Fellows of the Society:—

Chatterjee, Atul Chandra, I.C.S., 15, Eaton Rise, Ealing, W. (5)

Watson, Ralph Douglas, 12, Tankerville-terrace, Newcastle-on-Tyne.

THE CHAIRMAN, who, owing to another engagement, was obliged to vacate the chair immediately after the reading of the paper, said that whatever might be the merits of the Channel Tunnel with which the reader of the paper desired to link this country more effectually with its French allies, he also desired to bring English ideas with regard to our chief staple food more in accord with, and in closer approximation to, those which prevailed across the Channel. It was probable that bread, its relative availability in this country and in Germany, and its economic use, would prove to be a determining factor in the war. National necessity had forced upon the public mind the important issue of what constituted bread, properly so called, the truth about which the author, Miss Mary Yates and her friends had so long preached to an unheeding and sceptical public. He could sympathise very fully with the author in that matter, having suffered the same experience in preaching for many years the national crime of our utter lack of self-containedness in the matter of wheat production. It was an enormous source of satisfaction to him that there was a Corn Production Bill at present being seriously considered in the House of Commons, and he hoped it would be passed without any effective opposition, because he believed it would result in a very much larger area of the land of the country being devoted to the production of our most essential food, and, as he believed, in the greater prosperity of our hitherto somewhat unfortunate rural population. Nothing, to his mind, was more remarkable in the paper than the views of Mr. Stephen Terry as expressed in a letter written to the *Lancet* as long ago as 1882, which contained an analysis of the bread problem and a wise anticipation of the results of the then

contemplated new methods of milling. It was pointed out in the letter that there were four coatings to the wheat berry, and that all of them, except the first, viz. bran, contained valuable nutritious elements fit for human consumption and necessary to human efficiency. In his opinion it was necessary to be careful how nature and nature's gifts were interfered with, her balance thereby being destroyed either through ignorance, prejudice or purely æsthetic considerations which largely prevailed in regard to the production of white bread. A similar analogy might be found in other directions which were being discussed a good deal at the present time — the over-killing of those birds which prevented the ravages of injurious insects, or those which, like owls, fed largely, if not mainly, upon rodents. The war bread, whatever might be said of the normal loaf, was an almost complete human food—indeed, combined with either butter or margarine, it was a complete human food. That certainly could not be said of what the author had described as the anæmic loaf, with which everyone became all too familiar in pre-war times. He was not quite sure the author was correct in his statement that "Our milling friends now congratulate us on having attained what we have been struggling for." Under the stress of war conditions certainly more than one-half had been attained, and a bread had been provided which passed muster with the chief scientific critics, although it was not in all cases quite what was desired. Unfortunately the general public did not even now desire it, although they might accept it, *faute de mieux*, and therefore it did not pay the miller to supply the public demand. It reminded him to some extent of the case of brewing materials. It might be in the public interest to apply the whole of the raw materials of brewing, so far as they are still applicable, to the purposes of human food, but what was eminently expedient was not necessarily practicable; and it was just conceivable that, weighing one expediency with another, it might prove to be the more effective course, in the process of winning the war, not to deprive the whole of the working population even of the smallest quantity of beer simply because beer was made very largely of materials which were fit for direct human consumption as food. At any rate, statesmen had to consider the possible effects of any such course upon which they might embark; and the possible effects of too drastic action, although logical and to some extent expedient, might be very different from those which gentlemen who advocated the more drastic course seemed to imagine. Public opinion had to be educated, and he had not the smallest doubt that, if there was a public demand, the millers of the country, to whose patriotism he could bear full testimony, would be quite prepared in due course to meet it. Millers, however, had spent many hundreds of thousands of pounds on modern milling machinery, and they could not be expected to scrap it all and entirely alter their methods unless there was a certainty of a permanent demand for a somewhat different product not merely during but after the war. The educational value of war-time experience was very considerable in many directions, and it might be peculiarly effective in the direction to which the paper alluded. It taught a large degree of simple wisdom and a sense of proportion which some people, under the artificial conditions in which they had lived in this country for so many years, had possibly failed to entertain.

The paper read was—

BREAD AND FLOUR.

By Sir Francis Fox, M.Inst.C.E.

Having been invited by your Council to read a paper on Flour and Bread, I hesitated to comply, in consequence of the impending great changes that are probably coming in the supply of these important commodities, under the influence of the very strenuous days in which we are living.

It is, however, a subject for real congratulation that some of these changes, for which many of us have striven for years in the real interests of the nation, are rapidly approaching consummation and will result in increased health, in better teeth and bone. At the same time, much greater economy will be exercised by all classes, and the grievous waste of barley and sugar for the manufacture of beer and spirits will, it is hoped. be arrested, and these ingredients saved for actual food.

I desire at the outset to state that I have no pecuniary interest in flour nor wheat, nor in any milling enterprise. I have designed and erected several large granaries, but this paper is given solely in the interest of the community, and especially of the rising generation.

Nor do I pose as an expert on milling beyond the fact that for the last thirty years I have been brought into close contact with the trade, and have learnt many things of which I think the public should be informed.

About the year 1904 I formulated some of these results in an article on "Bread," and the late Mr. George L Craik, whom I met by chance at a friend's house, kindly read the manuscript, and at once offered to print it in *Macmillan's Magazine*, as he considered the subject of great importance. It will, therefore, be desirable that, as a matter of history, some portions of that article should be reproduced, to be followed by a statement of additional facts brought to light to the present date.

Bread, we are told, is the staff of life; it should not, therefore, be a waste of our time to try to learn what is known of it, and of the wheat and flour which are to make it. And yet, although we all live more or less by bread, there is hardly any subject upon which the ordinary public are more profoundly ignorant.

According to the returns of the Board of Trade, bread and flour constitute nearly half of the labouring man's solid food, and almost the sole diet of many poor children, and it is therefore most important, from a national point of view, that each of these commodities should be produced, and that the public should know and ensure that they are produced, in as pure and nutritious a form as possible. It was with this aim that the Assize of Bread was instituted at an early age, and in the year 1202 a proclamation was made for regulating the quality and price of bread. Four "discreet" men were appointed to carry out the provisions of this law, and the pillory and tumbril were the punishments awarded to those who broke or evaded it. It is to be feared that, were the Assize of Bread still in force, the modern system of flour-milling would to some extent infringe the enactments, and render some of our millers liable to its penalties.

Let us first briefly consider the growth and production of the cereal wheat, and notice some of the peculiarities attaching to it.

It is a tender annual requiring constant attention, and if left uncared for, and uncultivated, dies out. For instance, let a field be sown with wheat and then let it be neglected; the wheat plant will grow up and shed its grain, and this may possibly survive a mild winter, but in the course of two or three years there will be no trace left of the crop nor of the plant. Very different is this from the herbage for cattle, which grows everywhere unasked, and which covers very quickly any waste ground. Again, it is not only a tender annual, but it is remarkable for the very wide range of latitude in which it will grow. It is cultivated in the hot plains of India; it grows in the cold of Siberia, and even within two hundred and fifty miles of Klondike. It is believed there is no other plant which is adapted to such great changes.

Wheat requires the ground to be prepared for it, thus involving an enormous amount of labour. To till even one acre with furrows 12 in. apart compels the ploughman with his plough and team to travel eight miles and a half; if the field be fifty acres in area, it entails a journey of 425 miles. The grain has then to be drilled into the soil, and the field has to be rolled and harrowed. When the time of harvest arrives it has to be reaped, gathered and stored, threshed, and ground into flour. Finally it has to be baked and made into bread to gladden the heart of man. We are told that "In the sweat of thy face shalt thou eat bread," and this is strictly and literally true.

It is noticeable that the value of a crop of wheat depends, not only upon the quality and quantity of the grain, but also to some extent upon the crisp, bright, glassy character of the straw. The straw-hat trade of Luton and Dunstable, and other places in the neighbourhood, depend upon the fact that the straw used for plaiting is grown on adjacent chalk land. The plant has great affinity for the silica in the chalk and flints, and uses it for coating the outside of the stalk with that beautiful glass-pipe covering. And it is due to this fact that America, although she grows such enormous quantities of wheat upon her alluvial lands (having no chalk land), has to send to England for straw, through which her people consume their iced drinks, the straw being stiff and airtight, and therefore more suitable for the purpose than their own.

Let us next consider the constituents of a single grain of wheat—the fruit of the wheat plant—the principal and all-important ingredient in every loaf of bread. If a grain of wheat be cut in half and examined under a microscope, it will be found that beneath the outer covering which constitutes the bran and "sharps" there are two divisions. The larger one of these contains the white substance or flour, and the smaller, the germ or embryo of the future plant. It is the germ that provides in great measure the colour, the flavour, and the nourishment of the wheat. It is rich in proteid and fat, and its presence or absence in the flour makes a great difference between bread which is palatable and nutritious and that which is tasteless and to many unacceptable.

From the earliest ages until comparatively modern times, our ancestors had the wisdom so to grind the grain that the resulting flour contained the white substance as well as the nutritious elements of the germ. To this end they employed horizontal running stones—the upper and nether mill-stones of the Bible. From these issued a flour, wholesome and full of nutriment, but in colour, owing to the golden tinge of the seed-germ contained in it, not a dead white.

This was the flour which for centuries went to make the good old-fashioned home-made bread which our ancestors used, and which went to make our ancestors what they were.

Many of us can remember the introduction about forty to fifty years ago of "Pure White Hungarian Flour," and how it originated the demand, first of our housekeepers and cooks, and afterwards of our working-classes, for white bread. To enable the baker to supply this very white bread to the public, it became necessary for the miller to supply white flour. This could not be achieved by the use of the old-fashioned horizontal grindstones, which by disintegrating the germ tinted the flour. It became obvious to the miller that, to produce the white flour demanded, the colouring germ must be eliminated from it, and this he has succeeded in doing most effectually. The old upper and nether stones are put on one side, and for the production of white flour steel roller-mills are substituted. The first pair of steel rollers do not grind the berry; their mission is to crack the wheat and then to roll the germ into little discs, which do not go to make the flour at all, but are sifted out from the flour by sieves of silk. The result is that the public have achieved the white or anæmic loaf, but, in doing so, they have lost the best of the nutritive element of bread. The little discs of nutriment are used for various purposes, being bought, in some cases, by certain patent bread companies, but the bulk going to feed pigs and cattle, while our children are being regaled upon the less nutritious white loaf.

Formerly we were perfectly satisfied with our old-fashioned home-made bread, but now we have scores of different names for various breads, none of which are one whit better, and most of them many degrees worse, than the bread of old.

The following letter appeared in the *Times* of August 5th, 1904 :—

"SIR,—As I observe that the report of the Royal Commission on Physical Deterioration has been issued, allow me to call attention to another cause which is operating in a serious manner upon the people.

"I was informed a few weeks ago by a gentleman who owns large flour-mills, which produce 50,000 tons of flour annually, that the craze for white bread is being carried to such extremes that at the present moment many of the millers are putting up expensive machinery for the purpose of actually bleaching the flour. This is being done by ozone and nitrous acid; the object being to make an artificially white bread, and to enable grain to be used which would otherwise give a darker colour to the flour.* The development of the grinding process during the last few years has been such that the old-fashioned stones have been replaced by steel rollers actuated under great pressure. The result of this is that the germ and other most nutritive constituents of the wheat are to a great extent abstracted, and the valuable character of the bread greatly reduced.

"It is the opinion of many who can speak with authority on the subject that bread, instead of being as formerly the "staff of life," has become to a great degree an indigestible less-nutritive food, and that it is responsible amongst other causes for the want of bone and for the dental troubles in the children of the present generation. Some go so far as to connect it with appendicitis, and to express an opinion that the stamina of the nation is threatened.

"It is doubtless true that the variety of food now obtainable in a measure compensates, in the case of those who can afford it, for this abstraction of phosphates; but I think I am justified in stating that every medical man, if asked, will give it as his opinion that very white bread should be avoided and that "seconds" flour, now almost unprocurable, should alone be used either for bread or pastry. If the public will demand from their bakers this description of flour only, the millers will see that it is to their true interest to supply the more wholesome, the more nutritive, and by far the best-flavoured material."

This letter was written after consultation with several of the leading physicians, surgeons, and chemists of London, also with dentists, millers, and bakers carrying on large businesses.

The *Lancet* remarked :—

"We should be sorry for the person who tried to subsist entirely upon the modern uninviting loaf, made from blanched roller-milled flour."

It is stated that experiments were made upon two dogs; one was fed entirely upon brown bread, the other entirely on white bread; the latter died of starvation.

Brown bread, although excellent, does not suit every one—but this is not the description of bread referred to above. What one desires to obtain is of necessity slightly more golden in colour than white bread.

In "Food and Dietetics," Dr. Robert Hutchinson says :—

"In rejecting the germ and bran the miller undoubtedly discards some of the most useful chemical constituents of the wheat. A very white loaf means a loaf in which starch is at a

* "The commercial advantages of bleaching flour may be obtained, firstly, by using a *cheaper wheat* mixture; secondly, by increasing the higher grades of flour . . . and we are able to greatly improve the *colour* and *value* of even low-grade flours."—*Symon's Trade Circular*, 1904.

maximum and proteid at a minimum, and that is certainly not desirable."

The writer recently visited some flour-mills in which one part was still using the old-fashioned stones, the other portion of the establishment being devoted to roller-grinding. The official in charge of the former said that he considered that roller-grinding and abstraction of the germ ought to be prohibited by Act of Parliament. On visiting the roller-mill, the foreman of that department, being asked what advantages accrued from roller-grinding, replied, "It makes such superior flour." To the question what he meant by superior flour, he answered, "It is much whiter." He was next asked which was the more nutritious. "That," said he, "is quite another matter." The discussion was finally clinched by the question upon which flour he fed his family, and his reply was an eloquent testimony as to the pernicious character of the entire system, for he said, "I feed them upon stone-ground flour."

Bread made from flour which contains the germ is far more palatable and pleasant and will remain fresh for days. Such a loaf, after being kept for a fortnight, was found to be perfectly suitable for eating, for although dry on the outside, it was moist inside even after that length of time. Much of the roller-ground flour, on the contrary, makes bread which crumbles like sawdust within a few hours, is tasteless, produces with many indigestion, and gives but little satisfaction in any way, Minnesota and Cambridge digestion experiments notwithstanding.

The importance of feeding the Navy and Army upon the most nutritious flour is a matter of national importance, and the Government should thoroughly investigate the subject, especially as the cost of the better material is no greater, and probably less, than that of the inferior.

It is, or rather was, difficult to obtain the right description of bread, and it was therefore thought possible to protect one's self and family from the evil effects by consuming brown bread; but it was discovered that brown bread is frequently made by merely adding bran to the white flour.

The members of my audience should obtain a small quantity of the wheat-germ from a miller, and taste a few of the grains. No further argument will be necessary to convince them of the heinousness of the offence of abstracting this from the food of our population. It will at once bring back sweet memories of our youth, when walking through the cornfields we rubbed the ears of wheat in the palm of our hand, and enjoyed the delightful flavour of the grain. The objection has been raised that the germ renders flour rancid if kept for long; on the other hand, leading millers not only deny this, but say that flour, with the germ, will keep longer than without it. Prior to the introduction of roller flour, passenger steamers between England and India carried their supply of flour for both voyages with complete success, until this was prohibited by the Board of Trade on account of it not being snow-white.

I was told only a week ago by one of the Government Departments that flour sent to the Belgian Congo kept better if the germ were left in than that from which it had been extracted.

Let us recall to mind what Charles Wagner says in his interesting book, "The Simple Life," concerning bread and wheatfields:—

"By the bread that Christ broke one evening in sign of redeeming sacrifice and everlasting communion, we can say that wheat entered into its apotheosis. Nothing that concerns it is indifferent to us. What poetry in its sowing! in the black furrows, to which laborious hands are confiding the bread of the morrow . . . From the day that it comes out of the earth to the last rays of the October sun, throughout the long sleep of winter, the awakening in the spring, to the harvest in August, our anxious attention follows the evolution of the tender green blade, destined to become the nourishment of men. In time it is a swelling sea of green, constellated with poppies and the blue cornflower . . . In July the fields look like gold, and when the wind blows the stalks together we seem already to hear the grain running in the bushel measures. The bread sings in it in fine weather; but if the horizon darkens a shiver runs through the stalks, as in the heart of the peasant . . . At last is the harvest, the barn, the threshers, then comes the grinding in the mill, and the kneading by bakers or housewives. The bread is on the table. Before eating it, think that it is the fruit of the labour of men, and of the Son of God. Take it in gratitude and fraternal love. Do not suffer a crumb of it to be lost. Break it willingly with those who have none. As the wind blows, as the fountain flows, as the morning brightens, so wheat grows, for all."

Much of this pretty picture unfortunately does not apply to our own land. Go through France in August, and every field and every plot of ground has its bright patch of golden corn, and the whole population are busy, men, women, and children, from early morn into the darkness of evening, gathering in the sheaves. Even at night, when the harvest moon is up, the horses and waggons can be seen, outlined against a deep

indigo sky, still carrying in the lovely harvest of that country.

But cross the Channel and travel through Kent and Sussex, at one time the best wheat-land in Great Britain, and how changed is the picture! Hardly any wheat is to be seen, and, what is even worse, but little employment for the men; the agricultural labourer is rapidly diminishing in numbers, and the fields yield little labour for women or children. Are we wise in thus allowing the greatest industry of our country to die out on the plea of cheap food? To save a small amount upon each loaf by importing grain from abroad, the nation sacrifices an enormous item of labour for the people, and places the country, as shown by the report recently issued by the Commission on Supply of Food in Time of War, within measurable distance of famine-priced articles of food in the event of conflict breaking out between Great Britain and some other great Power.

The reckless pursuit of cheap wheat under the operation of Free Trade has brought us to the dearest bread that anyone can remember, and within sight of the possibility of no bread at all.

Thanks, however, to the war, the grave error of all previous Governments—of both parties—who neglected agriculture has been brought home to the nation in a manner which no amount of discussion would have accomplished. The cry of "back to the land" is heard on all sides, and, thanks to a better wage being fixed and a better price for grain being ensured, we shall doubtless make great progress towards rendering the country more self-contained.

The material which is separated from flour is termed by millers *offal*, which is a wrongly applied word, and one much to be regretted, as it conveys to the minds of people exactly the converse of the fact. According to the dictionaries, offal means, "the rejected or waste parts of a slaughtered animal, a dead body, carrion, that which is thrown away as worthless or unfit for use, refuse, rubbish." So far from this being the case with that which is abstracted from flour, it constitutes the richest, the most valuable, and most nutritious portion of the grain. Then, by additional grindings and siftings, the superfine white flour is produced. It contains less percentage of the original wheat (probably 68 to 72), requires more costly machinery and more elaborate processes, and when finished is a more expensive and less desirable product.

After working on the problem of better bread for a considerable time, I found that Miss May Yates and Mr. Stephen H. Terry, Engineering Inspector to the Local Government Board at that date, were already engaged in a similar crusade.

It is an interesting fact that the evils of roller-grinding were predicted by Mr. Stephen H. Terry in a letter written to the *Lancet* so long ago as June 10th, 1882; he seems to have been gifted with prescience upon this subject, and he is still bringing his influence to bear in the efforts to recover to the people of these lands the old-fashioned farm-bread of our forefathers. "The second, third and fourth coatings of the grain," he wrote, "contain nitrogenous substances, phosphates, and other salts which are necessary for the formation of bone, teeth, and muscle"; and in later communications he has said that "indigestible food, or food made so by preservatives and cloying bread, is the predisposing cause of appendicitis."

I cannot do better than quote his letter at length, from which it will be seen that Mr. Terry was one of the first, if not the very first, to call public attention to the pernicious grinding of snow-white flour:—

"Sir,—The sciences of Medicine and Engineering go hand in hand in matters connected with the sanitation of dwellings. I think they may also work together in the preparation of food supplies. At a meeting of the Institution of Civil Engineers, held on Tuesday, May 16th, three papers were read by Messrs. Baker, Simon, and Harding, dealing with improved methods of preparing flour from corn, the objects of these methods being to produce by means of roller mills the largest bulk of white flour from a given quantity of corn, and to separate entirely, by silk-gauze dressing machinery, all bran, pollard, sharps, and toppings from the flour, thus producing a flour of almost perfect purity and of dazzling whiteness, for which there is, unfortunately, a growing demand in this country. Now, it is well known to chemists and medical men, though not to the general public, that such flour, whilst it has lost the rough exterior, the first coating of bran, containing silica, has also parted with nearly all of the second, third, and fourth coatings, containing as they do nitrogenous substances, phosphates, and other salts, which are so necessary for the formation of bone, teeth, and muscle.

"When it is borne in mind how large a portion of the population of this country (more especially children) live principally on bread in some form or other, and that whilst growing they require a larger portion of bone and tissue-forming material than at a later period, I think the medical and engineering professions will agree

with me when I state that the processes involved in the preparation of bread from grain should be such as to leave in the resulting loaf those elements which entitle it to its ancient name, "The Staff of Life," and that the changes in the chemical composition of bread which are likely to follow an extended use of improved mill machinery ("high-grinding") are well worthy the attention of medical men.

"The system of high-grinding has been in use to a considerable extent in Hungary for some years, but the absence of bran in the Austrian and Hungarian white bread is made up for by the large consumption of rye-bread, which is eaten by all classes, and is not confined in its use to the poor, as many people erroneously imagine. The following tables show very clearly how large a proportion of valuable bone-forming material is lost by complete separation of the bran, even under the old system of milling; whilst by the Hungarian system the bran is squeezed between the rollers and parts with all the adherent flour, the bran remains entire, none is ground into small particles, consequently none remains with the flour after dressing, and chemical analysis of flour so produced would be almost entirely free from salts, and contains less nitrogenous substance than the samples given in the tables." —June, 1882.

COMPOSITION OF FLOUR AND BRAN FROM PELIGOT AND BIBRO.

(The figures are the means of fourteen analyses.)*

		Parts in 100.	
		Flour.	Bran.
Water		14·0	10·3
Fatty Matters		1·2	2·82
Nitrogenous Substances insoluble in water	Gluten	12·8	10·84
Nitrogenous Substances soluble in water	Albumen	1·8	1·64
Iron-Nitrogenous soluble Substances	Dextrine Sugar	7·2	5·8
Starch		59·7	22·62
Cellulose †		1·7	43·46
Salts (Phosphates), etc.		1·6	2·52
		100	100

* Parkes' "Hygiene," Fifth Edition, page 222.

† The cellulose named above is that of the entire grain cells and all (husk and interior). Potash, phosphoric acid, with magnesia, are the principal salts.

Dr. Parkes states, on page 223, that the nitrogenous matter in bran is sometimes as high as 15 per cent., with 3 per cent. of fat and 5·7 per cent. of salts.

To Miss May Yates, as Hon. Sec. of the Bread and Food Reform League, the nation owes a deep debt of gratitude for her ungrudging and ceaseless labour to secure proper flour, and to stop the unwarrantable polishing of rice and pearl barley. Her efforts were stimulated by a meeting she organised at the Mansion House in 1880, and she is now being rewarded by the great measure of success—the results of her labours.

But in many other ways Miss Yates has enlightened the public and the various authorities by lectures and speeches on the relative values of all kinds of food, especially in the interests of the working classes and of the poor women and children of our great cities. It would be a fitting and well-earned reward were our Government to confer some honour and pension on this devoted lady.

Before the war period one of our leading roller-millers, to whom I appealed to make experiments with the view of producing better and richer flour by his roller-mills, succeeded in his efforts, and manufactured an excellent flour which he named "Verold," an abbreviated form of "very old," as claiming to be similar to the original old-fashioned material upon which the world has been fed from the time of Adam.

I think I am safe in saying that the best flour can be produced with less than one half the number of rollers required for the snow-white flour, and this ought to result both in increased output and in reduced cost.

There is no doubt, however, that stone-ground flour possesses a creaminess and nutty flavour which cannot be imparted by rollers, and this is believed to result from the degree of heat produced by the friction between the stones.

I recently called the attention of the Board of Trade, the Local Government Board, and the Board of Agriculture to the great importance of increasing the percentage of flour from a given quantity of wheat, and the following figures will appeal to all: 100 tons of wheat produce about 70 tons of the very white flour; 100 tons of wheat produce 86 tons of the desired flour, thus saving 25 per cent. of the necessary freight; 100 tons of wheat produce 99 tons of wholemeal flour, which, if finely ground to an impalpable powder, produces the richest and most nutritious flour: this represents a saving of 41 per cent. of the freight.

We need have no fear of our bread if even barley and rye be mixed in suitable proportions with wheat flour. Now that the Government

are taking over the flour-mills of the country they can insist upon a proper mixture, and the necessary uniformity of the product. Many of us are acquainted with certain Continental breads of these admixtures, and are aware of their excellence, and we read of "the five barley loaves and two fishes." Whenever I travel in foreign countries, instead of using the fancy and white breads usually supplied to hotel guests, I invariably endeavour to purchase the bread made by the peasantry and for the working classes, as being more nutritious and much more pleasant to the taste.

Now we come to these war days, when it has been found necessary to interfere with the milling. The first decision was to prohibit absolutely the very white, or 70 per cent. flour, and this great improvement would never have come about had the war not taken place, for we are, or have been, absurdly conservative in many ways.

It is rumoured that the germ is still being extracted. This should be prohibited as it materially diminishes the food value of the flour.

Some of the strongest opponents in this crusade for better bread have been our milling friends, who now congratulate us on having attained what we have been struggling for, and they add, that "the recent bread is much more palatable."

This results in great measure from the germ being retained, and although the percentage is only 1½, the potent influence does not depend on its weight. Probably it can in some way compare with the influence of "enzymes" and "vitamines" which, although invisible and almost imponderable, nevertheless are very important factors in the value of various foods.

It has recently been discovered that the vitamines are chiefly in the germ and the outer part of the grain, the very parts which, by roller-milling, are removed in producing white flour. This no doubt is the explanation of this material not being so nourishing as 81 per cent. flour. The children of the poor, fed on white bread, jam, and tea, are ill-nourished and sickly.

Under the new Orders of Lord Devonport of January 29th, March 12th, and April 4th last, every miller is required to increase the percentage by not less than 5, bringing it up to 81 per cent. on the schedule, either by a further milling and extraction of flour from the wheat, or by the addition of flour derived from barley, maize, semolina, rice or oats, of not less than 10 per cent., or, at his option, of not more than 25 per cent.

A system of spraying wheat, known as the "Loring system," facetiously described by a leading baker as the loading system, has recently been introduced, and although certain high authorities state that this does not add to the weight, equally high authorities distinctly say that this is not only incorrect, but that it is unfair to honest millers and to the consumers, and that it is against the interest of British wheat. Upon this subject I do not attempt to express an opinion, but it should be carefully investigated and discussed. Five years ago people would have been prosecuted for adulterating bread. To-day they will be prosecuted if they do not do so.

I desire to point out that the chemistry of wheat and the science of grinding are making important advances. The word "vitamine" has only come in of late years, and as yet the subject is not fully understood. It was first applied by Professor Casimir Funk, of the Lister Institute, and, so far as I can comprehend it, the best definition is that it is the vitalising element in all food-stuffs. It can be extracted by means of alcohol and is not destroyed by cooking.

It is, however, a valuable illustration of the fact that the importance of any ingredient in food is not to be measured or judged by its percentage. Some ingredient of microscopic size, and almost imponderable, makes all the difference between wholesome and unwholesome food.

One word of caution is desirable—that whilst increasing the yield of wheat and cereals throughout the country, every effort should be made simultaneously to increase the area of land under vegetables of all kinds, not only in gardens and allotments, but in large farms. An acre of land will produce a greater amount of food value under vegetables than under wheat.

No finer occupation could be found both for men and women than for them to work on such farms.

I am of opinion that the public are indebted to the bread reformers for having exposed the pernicious practices of bleaching flour—of extracting the germ; and also of the polishing of rice and pearl barley. Beri-beri resulting from polished rice was first discovered at Rangoon, and this alone is a full justification for prohibiting rice puddings made of polished rice.

In conclusion, I have to apologise for any shortcomings in this paper as being due to the strenuous and anxious times in which we are living, and the anxiety of mind which is not absent from any one of us; consequently, it has proved difficult to carry on a continuous line of thought or of research.

[At the conclusion of the reading of the paper the chair was vacated by Captain Bathurst and occupied for the remainder of the meeting by MAJOR PERCY A. MACMAHON, F.R.S., Deputy Warden of the Standards Department, Board of Trade.]

DISCUSSION.

MR. A. E. HUMPHRIES, in opening the discussion, said that, as a miller, it seemed to him that one of the fundamental misconceptions which underlay almost all the arguments used by the author and his friends was the assumption that wheat was meant by Nature to be a food for man. That, he thought, was wrong. Wheat was meant by Nature to be a seed and to reproduce its species, and when it was taken from its true function in Nature, and used no doubt for a perfectly legitimate purpose in the making of flour, it must be borne in mind that it had been diverted from its original function. Starting with the conception that wheat was a seed, that the outer cover was meant to be the food of the baby plant inside, and that it was made up very largely of relatively indestructible matter, by what reasoning was the logical conclusion arrived at that people were called upon to eat it? He had no more hesitation in throwing away the husk and the bran of wheat than he had in throwing away the shell of a nut or the skin of an orange. The arguments in favour of wholemeal 80 per cent. bread were, it seemed to him, founded on misconceptions. It was stated that wheat was nature's gift as food, and that it ought to be eaten in the form in which nature supplied it. On the other hand, he contended it was essentially a seed, meant by nature to be a seed, and that when it was diverted from its proper function and used as a food for human beings it was not only excusable but absolutely right to take that part of the seed which was in the highest degree suitable for human food and discard the other part, except in the indirect way that if he desired to eat the husk of the wheat he preferred it in the form of milk or bacon. In the paper he read before the Society eleven years ago, he used the argument that the germ was by nature resistant to disintegration, and that there was no well-founded argument for believing that the germ existed in millstone flour at all, but that it was in what was called the offal. As a matter of fact, he had extracted the wheaten germ from offal, which was being sent away for consumption by pigs; and he unhesitatingly said from his milling experience that it was an entire fallacy to suppose that the germ was wholly in the millstone flour, or even a very large proportion of it. It was an entire mistake to suppose that millstone flour contained substantially more of the germ than roller flour. No proof had been adduced by the author in support of the statements he had made, and he (Mr. Humphries) was content to leave the question there. In his opinion it was absurd to say that the offal was more nutritious than the other part of the wheat, because experiments that had been made definitely proved that white bread was much more digestible than any other variety. He desired to emphasise the point that there was another side to the story told by the author, which he thought was based on scientific facts, but if the author or anybody else could convince him to the contrary he would change his opinions.

COLONEL CHARLES E. CASSAL said that Mr. Humphries' defence of the use of super-white flour had left him entirely unconvinced. As a public analyst with a somewhat lengthy experience, he desired to endorse in general terms the views set forth by the author, although he did not agree with one paragraph of the paper referring to beer and spirits, because he believed both those substances were necessary under certain conditions of life, and that it would be a very serious error at the present time if the views of temperance cranks were adopted and the production of beer absolutely abolished. There was no question that, by the extraction of the germ from flour, a very valuable nutritive material was lost which ought to be, and which used to be, present in bread. It was an unquestioned fact that the old-fashioned bread of twenty or twenty-five years ago was far different from the white bread of to-day, and much more nutritious, the difference probably being due to the presence of a substantial proportion of the germ in the old-fashioned bread. One iniquity led to another in matters of food, and the custom of polishing rice and barley was a form of iniquity which had led to another. In order to produce polished grain it had been the custom of rice polishers to use for some years past soap-stone or powdered talc, which was an insoluble mineral substance added to the rice or barley and pounded up with it, the result being that substantial proportions of foreign mineral matter were left in the article, so that instead of the total mineral matter in genuine rice not exceeding about ·5 per cent. it rose to 1·5 and 2 per cent. Although prosecutions had been taken for the sale of rice containing extraneous talc, the public generally did not appreciate the seriousness of a form of adulteration which involved the ingestion of an article of food containing an effective proportion of an irritating insoluble mineral substance. The demand for whitened flour led to the bleaching of flour by means of nitrous fumes, the use of which resulted in the presence of substances known as nitrites in the flour. For many years

past a great majority of the samples of flour taken under the Food and Drugs Act for analysis by public analysts had contained definite traces of nitrites. It might be said that the presence of minute traces of nitrites in flour might be neglected, but so little was known of the physiological effects produced that it was extremely dangerous to permit ignorant manufacturers and others to make use of chemicals for producing certain results in articles of food without the slightest idea of what the ultimate results might be on the consumer. He thought the last speaker's simile in reference to the husk of the grain and the nut-shell was inapplicable. It might be applicable to the outer husk of the grain and possibly to the bran, but it was not either to the germ or the inner coatings, the great proportion of which when ground up were absolutely lost by the 70 per cent. process of flour production. In his view, as a public analyst of long experience, the author had made out an extremely strong case, the importance of which it was hoped the Government would appreciate. Unfortunately the Government authorities had sought advice from those least capable of giving it, and in the Orders which had been promulgated the use of a certain proportion of maize in preparing flour was permitted. That was a very serious mistake which ought not to be allowed, although there was no very great objection to barley, rye and rice. Maize contained a certain amount of oil, and it was almost impossible to free the maize entirely from it; and that oil was, he would not say injurious, but at any rate it produced effects, even in very minute quantities, which led to indigestion.

Mr. Stephen H. Terry said that in his early days he had the advantage of the run of a small flour-mill in Hampshire, where stone-milling was done, and the miller viewed with horror the growing craze for white flour, which, he told him, he was convinced would be very injurious to the human race. Many dentists were of the opinion that the cause of bad teeth was very largely traceable to the use of white bread—not that the white flour was positively injurious, but that it did not give the same nourishment as the old-fashioned flour. Much confusion existed amongst the public as to the object of the author and those who thought with him, and many hard things were said about the movement. For instance, one newspaper had said that all those who were in favour of standard bread were cranks, which would, of course, include the distinguished author of the paper and a man like Sir James Crichton-Browne. It was necessary to educate the public as to the object of the movement, and the benefit that would result from it if its plans were adopted.

Mr. William Vernon said that after the *Daily Mail* standard bread campaign his firm put themselves out to make an 80 per cent. flour, of which at first they sold 2,000 or 3,000 sacks a week, but the demand gradually went down to 100 sacks a week. Personally, he much objected to people interfering with a trade which they did not understand, and not going to the correct source to obtain information. At present the Government seemed willing to listen to anybody. He hoped those present would remember that there was another side to the question than that put forward by the author, and that the country would not come to such a pass as to go back to the bread used in antediluvian times.

Mr. W. Jago said that, it having been his duty to study the chemistry of wheat flour and bread for over forty years, he joined issue with almost every conclusion at which the author had arrived. As the result of his study, he was convinced that white bread was far more nutritious than any dark bread, and the committee appointed by the Royal Society and other eminent scientists were all of the opinion that white bread was much more digestible. He had been much struck with the author's statement that old-fashioned bread had made our ancestors what they were. In the last twenty-five years that bread had not been obtainable, and notwithstanding that fact this country had in the last two or three years placed on the Continent the finest army the world had ever seen. White bread had made them what they were, because they were all raised on it; and experience proved that as soon as the present times of stress were over the nation would go back to it again.

Miss May Yates said it had been shown in regard to the Minnesota experiments that the indigestibility of wholemeal bread was caused by the meal not being ground fine enough. The Bread and Food Reform League had sent an application to the Royal Society asking them to reconsider the opinion expressed in regard to the very great difference in the digestibility of 80 per cent. bread and 70 per cent. bread, because the experiments on which the statements were based did not at all deal with what was called 80 per cent. bread; and if the experiments that were made at Cambridge had also been made with the proper 80 per cent. bread very different results would have been obtained. The Report did not deal in any way with the phosphates or vitamines which were equally essential to the sustenance of life, and to base an appeal simply on protein was absolutely illogical and unscientific.

Lieutenant-Colonel Allan J. C. Cunningham mentioned that the inhabitants of the Upper Provinces of India were essentially a wheat-eating population, and they were a fine virile race. They did not use white flour, but flour with a little of the bran extracted. The wheat was coarsely ground, and it was almost the staple diet of the natives, among whom dentists were unknown.

PROFESSOR H. R. KENWOOD said that, so far as the question of indigestible material was concerned, he was not aware of any experiments which showed that 80 per cent. flour was less nutritious or was not more nutritious than 70 per cent. flour. Even when allowance was made for the fact that there was rather more indigestible material in the 80 per cent. flour, the material which was digested produced proteins of higher nutritive value. The term "indigestibility" was used as if it was something very disadvantageous, but personally he thought the slight increase in indigestible material in 80 per cent. flour was rather an advantage than a disadvantage. All food contained indigestible material, and it played a very important function, not only as food but in determining the proper physiological action of the digestive apparatus. Even if it gave rise to indigestion, it possessed an extremely good set-off in the fact that it was a very important agent in preventing constipation. As a medical man he could testify to the fact that constipation was far more general among the population than indigestion, and constipation was very commonly the cause of indigestion. From the medical and hygienic standpoints, apart from the extra nutritive value which the individual could obtain, as proved by experiment, the addition of a small amount of indigestible matter was an added factor in favour of the 80 per cent. flour.

SIR FRANCIS FOX, in reply, said that he was not connected with the Bread and Food Reform League, and his only desire was to be perfectly impartial and to get at the real truth. In reply to Colonel Cassal, he desired to say that he was not an advocate of total prohibition without some form of compensation on a very moderate basis. He thought to impose total prohibition without some compensation of that kind would be un-English. He had protested for years against the polishing of grain by soap-stone and talc, and he hoped eventually it would be prohibited by Act of Parliament.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded to Sir Francis Fox for his interesting paper, and the meeting terminated.

THE NATIONAL WAR MUSEUM.

The announcement that the Cabinet has decided to establish a museum to commemorate the war comes none too soon. Indeed, in these days of rapid thought and constant change many of the relics of the greatest value for the future have either been destroyed or are in imminent danger of loss. Other memorials—and particularly the sort of things which are expressive of the action, the experiences, and the endurance of individuals —have already passed into private hands. If the assemblage of official exhibits already promised to the museum is to be made alive by the acquisition of characteristic private letters, sketches, maps, and trophies, which will be typical of life in the Fleet or at the Front, the hearty co-operation of their present owners is essential.

There can be little doubt that a museum which is to be representative of the operations of the Navy all over the world and of the Army on all fronts, and which is to have sections devoted to each of the Dominions and to women's work, will have the whole-hearted support of the British public. But in order to stimulate interest in its collection it is highly desirable that a decision as to the site or buildings to be occupied by the museum should be taken at an early date. As a result of such a decision, the individual—whose gifts will be so welcome—will be encouraged to make the necessary personal sacrifices, for no collector desires to part with his possessions until he knows their future whereabouts.

As it is essential that the war museum should be so located that it can be easily visited by the public, British and foreign, and as there must be sufficient space for the "tanks," big guns, and other engines of war which cannot be housed in buildings, the Tower appears to be the place most suitable for the purpose. Whilst the Moat is spacious enough for the accommodation of all the larger trophies, the buildings at present utilised for barracks and storehouses could easily be converted in a manner to render them quite suitable for the collection itself, for the war books, and for the records. The adoption of this idea would have the dual advantage of placing the museum in a centre which is already so full of historical interest, and of rendering possible the artistic improvement of buildings which at present are entirely out of keeping with those by which they are surrounded.

INDIAN CASHEW-NUT INDUSTRY.

The cashew-nut tree (*Anacardium occidentale*), originally introduced from South America, is established in the coast forests of India, especially in sandy places. In South India it is important in coast-dune reclamation.

Until twelve or fifteen years ago cashew was a jungle product, and the nuts gathered were mainly intended for consumption in the country and in the Gulf ports, where a considerable demand exists among the Arabs. The total output, however, under such conditions never exceeded 1,500 to 2,000 cwt. The advent of European firms in the business, says the United States Consul at Madras, gave an impetus to the trade, and to meet the increased demands the product began to be regularly cultivated.

South and North Canara, on the western coast of the Indian Peninsula, is the home of the cashew tree in India, and of late years large tracts in Malabar and Travancore have also been planted with it. The fruit yielded by the tree is commonly known as cashew apple; it is eaten only by the lowest classes, and quantities of it

are wasted. The crop season is between the end of March and the beginning of May.

The nuts are attached to the top of the cashew apple. After being detached, they are dried, packed in robbins (or bags), and roasted over an ordinary charcoal fire. They are removed hot, and the outer shells are broken by means of stones, the kernels then being removed and sent to the market for sale. As they are generally very damp when they reach the South Indian buyers and are liable to spoil, the buyers' representatives, upon receipt of the supplies from the natives, usually cause the nuts to be spread out in the sun for two days. The brown and rancid nuts are garbled out, and the article is then ready for export.

Something like 15,000 cwt. of these nuts are now exported in an average season to England, France, and America, the principal port of shipment being Mangalore.

Cashew nuts are prepared for table use in much the same manner as roasted almonds, the flavour of which they are said to resemble slightly. They are not unlike almonds in shape, though thinner and more elongated, and many of them are concavo-convex. The exported nuts are no doubt bought chiefly by East Indians residing in foreign countries, or by persons who have acquired a taste for them by residence in India. They are sometimes made into confectionery with sugar.

ARTS AND CRAFTS.

De Morgan and Martin Ware at the Victoria and Albert Museum.—It was a happy inspiration, and a fitting tribute to the memory of a great pioneer, to organise the little exhibition of Mr. William De Morgan's work at the Victoria and Albert Museum. The circumstances of the time have prevented the show from reaching the dimensions which might have been expected, for though many people have lent pieces, some of the best work is still in Paris, whither it was sent for the Arts and Crafts Exhibition of 1914, and one misses any large plaques of tile work. But, for all that, there is enough to be seen to demonstrate the many-sidedness of Mr. De Morgan's efforts, for they were manysided in spite of his leanings being all on the side of Persian, Italian, and Hispano-Moresque work. The happiest examples at South Kensington are undoubtedly those in which the prevailing colours are blue and green, with a touch of manganese purple; and some of the large plates and vases decorated with foliage or fishes are beautiful examples of fine juicy pot colour. The lustre is perhaps less interesting than it would have been some years ago, when other makers were either not producing lustre at all or not doing so very successfully; but much of it is still very attractive, and some of the colour is very delicate and pearl-like. One is struck by the very large scale of some of the decoration, which rather gives the impression that the work was only meant to be seen at a great distance, and also by the prevalence of animal forms, which in the days when De Morgan was producing were far less commonly used in ornament than they are now. Time, again, has not always dealt kindly with the ware. Its body is apparently very coarse, and the enamel seems not to have fused very well with it and to have chipped off rather freely. Still, the exhibition, incomplete as it avowedly is, helps one to realise how very much De Morgan did for the revival of artistic pottery in this country, how far in advance he was of his time, and to what excellent models he reverted. The two cases of work by the brothers Martin, shown at the same time, are in many ways an admirable foil to this large and brightly-coloured ware. The pieces are mainly small and rather sombre in colour, as befits stoneware, and they depend for their charm on their absolute fitness in shape and colour for the material in which they are executed. They make one realise their texture, and regret the dividing glass which prevents one from handling them. The authorities have had the wisdom to exhibit in the wall-cases specimens of the best-known English and foreign pottery. There are examples of Szolnay, Rookwood, Royal Copenhagen, Delaherche, and Wedgwood—to mention only a few names; whilst on the partition wall at the far end of the room are two large tile panels executed by Pilkingtons from designs by Lewis F. Day, and a dozen flower-figure tiles by Walter Crane. The visitor is thus given ample opportunity for estimating the position both of the De Morgan and the Martin ware and its influence on modern work.

Art Teaching in London Trade Schools.—The girls' trade schools have been rather hampered by the war. Girls as well as boys find it much easier than formerly to get a well-paid berth as soon as they leave the elementary school, and parents are not always far-sighted enough to see that it is wiser to let their girls be thoroughly trained for a trade than to rush into some employment which offers no real prospect of advancement or even of permanent employment. Still, the trade schools are continuing their work, and the numbers in their classes, if not quite so large as formerly, are well maintained, and the artistic side of their work is very prominent. There is a good demand for qualified embroideresses at present. Not only dresses, but coats and skirts are generally embroidered nowadays, and the girls who are trained in the schools are taught machine as well as hand embroidery, and how to combine the use of both methods. They are trained in drawing and elementary design, and are given opportunities of studying good old work. They should, therefore, not only do well for themselves, but also tend to lift the workshop standard of taste, whilst their preliminary grounding ought to make them in the long run capable of doing something to raise the status of English trade embroidery. The upholstery students at the present time, besides being given

some general art training, are taught machine embroidery and learn how to use appliqué. The dressmakers, again, study simple hand embroidery of the kind which may be useful to them in their work. One cannot but feel that nowadays it is to the technical and trade, rather than to the art, schools that we must look for that artistic leaven which we are all hoping will do so much in the future to raise the level of English craftsmanship, and to bring about that general amelioration in industrial conditions which all thinking people desire. Art schools, of course, have their place in the general scheme, and a very important one too; but their operations cannot be expected to cover so much ground as those of the technical and trade schools, especially if the new educational measures are going to raise the school-leaving age or make attendance at continuation classes compulsory.

GENERAL NOTES.

Utilisation of Blood at Public Slaughter-houses.—Experiments have been recently made at the public abattoir in Milan for utilising the blood of the animals slaughtered there, for the production of a cheap and wholesome food for the people. The quantity of blood available for this purpose at this establishment is estimated at 30,000 kilos, or about one ton per day. After undergoing a preliminary process, in order to remove any fibrous matter, the blood is mixed with wheaten flour and other ingredients, and then made into cakes or pastry and baked in the oven. Five different kinds of cakes are made, two of which, containing 20 and 30 per cent. of flour, are sold retail at 50 and 60 centimes per kilo respectively. The other kinds, containing 60 per cent. flour, 10 per cent. sugar, 20 per cent. blood, and 10 per cent. pork lard, are sold at from 1 lire to 1.20 lire per kilo. In some cases dried raisins or currants are added. These make an excellent lunch cake for the children attending the municipal schools. Various kinds of black puddings, which differ only in the ingredients added to the blood, are also made. Pies and patties, containing a mixture of blood, flour, and other ingredients, are sold at Bologna and other Italian towns on the occasion of certain festivals.

The Province of Hunan.—Hunan, writes the United States Consul at Changsha, is chiefly an agricultural province, although it has large mineral resources which are being rapidly developed. The most commonly exported of its products are beans (to Europe for cattle feed), bristles, grass cloth, human hair, hides, and tea. To these should be added wood oil, which is exported to the United States in large quantities, where it is used in the manufacture of quick-drying varnish and tea oil. Sesame-seed oil and rape-seed oil are exported to a certain extent. Foreign merchants having agents at Hankow have established their warehouses and refineries for the collection and refining of these various products. Hides are collected one at a time by the dealers and sent to the hide-drying yards of the Hankow merchants, where they are treated, graded, and press-packed before shipment. The oils are collected at Hankow and are allowed to settle, and are then graded and put into barrels for shipment. The same procedure is followed in the case of bristles and other raw products. Few of these products go to the United States under the name of the Chinese producer, as the packing, refining, and shipping are entirely in the hands of the foreign export merchant and the products go out under his name.

Coal in the United Kingdom, 1916.—The number of persons employed at mines in the United Kingdom in 1916 was 998,063. This figure shows a decrease of 129,827 persons on the pre-war year of 1913, but an increase of 44,421 on the figure for 1915. The output of coal, which fell from 287,411,869 tons in 1913 to 265,643,030 tons in 1914, and to 253,179,446 tons in 1915, showed a slight recovery in 1916, and amounted to 256,348,351 tons.

Discovery of Coal in Italy.—It has been recently stated by *La Stampa* that from boring operations made last year in the Province of Novara, the existence of an important bed of coal has been ascertained. It is also rumoured that the Italian Government intend taking steps to utilise the discovery. It may be mentioned that Italy, up to the present time, has been dependent on other countries for this fuel, and during the two last years has been feeling the pinch, her supplies from Germany, Belgium, and France having been practically cut off. She imported about 11½ million tons of coal from England during the two years ending December, 1916, and a considerable quantity from America.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 2.—J. C. Shenstone, F.L.S., M.P.S., "Herb-growing in the British Empire: its Past, Present, and Future." Sir Robert Armstrong-Jones, M.D., F.R.C.P., F.R.C.S., will preside.

May 9.—Professor William Ripper, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

May 16.—Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

May 17.—A. C. Chatterjee, I.C.S. (United

Provinces), "The Development of Banking and Thrift in India."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

MAY 8.—CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

HOWARD LECTURES.

Monday afternoons, at 4 p.m. :—

WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Iron Ore Supplies." Two Lectures. (1) Available Home Supplies of Iron Ore; (2) Overseas Iron Fields which Supply the British Market.

April 30, May 7.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Howard Lecture.) Professor W. G. Fearnsides, "The National Shortage of Iron Ore Supplies. Lecture I.—Available Home Supplies of Iron Ore."

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Sir Duncan C. Baillie, "The Position of Tenant Cultivators in the United Provinces."

TUESDAY, MAY 1...Faraday Society, at the Chemical Society, Burlington House, W. 1. General discussion on "Osmotic Pressure," to be opened by Professor A. W. Porter. 2. Dr. F. Tinker, "The Colloidal Membrane: its Properties and its Function in the Osmotic System." 3. Mr. W. R. Bousfield, "Osmotic Pressure in relation to the Constitution of Water and the Hydrates of the Solute."

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Tetanus: its Prevention, Symptoms and Treatment." (Lecture I.) 5 p.m. Annual Meeting.

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. C. M. Thomas, "Wet Gelatine Emulsions: a demonstration."

Anthropological Institute, 50, Great Russell-street, 5 p.m. Mr. J. Reid Moir, "On some Human and Animal Bones, Flint Implements, etc., discovered in two ancient occupation-levels in a small valley near Ipswich."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Professor H. Maxwell Lefroy, Lantern Exhibition of the Wild Silk Moths of India. 2. Professor J. P. Hill, Exhibition of a gyandromorphic Earwig (*Forficula auricularia*). 3. Dr. A. Smith Woodward, Exhibition drawings of the molar tooth of *Eoanthropus*.

Roentgen Society, Cancer Hospital, Fulham-road, S.W., 8.15 p.m. Discussion on "The Future of the British X-Ray Industry."

WEDNESDAY, MAY 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. C. Shenstone, "Herb-growing in the British Empire: its Past, Present, and Future."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain C. J. P. Cave, "Some Meteorological Conditions which Increase the Risks of Flying."

Shakespeare Association, King's College, Strand, W.C., 5.30 p.m. Meeting to promote annual "Shakespeare Day" in schools.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. A. D. Powell, "The Estimation of Phenacetin and Allied Compounds by means of Hypochlorous Acid." 2. Messrs. W. R. Schoeller and A. R. Powell, "A Rapid Method for the Determination of Nickel and Cobalt in Ores and Alloys." 3. Mr. J. Webster, "Note on Opium Poisoning Cases."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Sir J. Wolfe Barry, "The Standardisation of Engineering Materials, and its Influence on the Prosperity of the Country." (James Forrest Lecture.)

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. G. G. Coulton, "Some Notes on Mediæval Masons' Marks and Graffiti."

THURSDAY, MAY 3...Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10.30 a.m. (Annual Meeting.) 1. Mr. J. N. Kilby, "Steel Ingot Defects." 2. Mr. F. C. Thompson, "Influence of Surface Tension on the Properties of Metals, especially of Iron and Steel."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 8 p.m. 1. Mr. H. W. Pugsley, "A Monograph of the Genus *Fumaria*." 2. Mr. G. M. Ryan, "On the Flowers of the Mahua, *Bassia latifolia*, Roxb." 3. Mr. C. D. Sherborn, "An Autograph of Vice-Admiral Bligh (1754-1817)." 4. Mr. C. C. Lacaita, "On Two Critical Plants of the Greek Flora." 5. Dr. W. E. Collinge, (*a*) "On *Paracubaris*, a New Genus and Species of Terrestrial Isopoda from British Guiana"; (*b*) "On the Oral Appendages of Certain Species of Marine Isopoda."

Metals, Institute of, at the Institution of Civil Engineers, Great George-street, S.W., 8.30 p.m. Professor W. E. Dalby, "Researches made possible by the Autographic Load-Extension Optical Indicator."

Chemical Society, Burlington House, W., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor G. Murray, "Pagan Religion at the Time of the Coming of Christianity." (Lecture I.)

FRIDAY, MAY 4...Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10 a.m. (Annual Meeting continued.) 1. M. L. Grenet (Firminy, France), "The Penetration of the Hardening Effect in Chromium and Copper Steels." 2. Mr. F. C. Langenberg (Harvard, U.S.A.), "Cementation by Gas Under Pressure." 3. Mr. G. P. Raidabaugh (Sparrow's Point, U.S.A.), "Origin and Development of the Railway Rail." (Being a historical note communicated by the courtesy of the Ebbw Vale Co.) 4. M. N. Tschischewsky (Tomsk, Russia), "Case Hardening of Iron by Boron. 5. Messrs. N. Tschischewsky and N. Schulgin (Tomsk, Russia), "Determination of the line S.E. in the Iron-Carbon diagram by Etching Sections at High Temperatures in Vacuo."

Royal Institution, Albemarle-street, W., 5.30 p.m. Mr. H. Wickham Steed, "Some Guarantees of Liberty."

Geologists' Association, University College, W.C., 7.30 p.m. 1. Mr. J. F. N. Green, "On the Correlation of the Ingletonian Slates." 2. Mr. C. W. Osman, "The Landslips of Folkestone Warren and the Thickness of the Lower Chalk and Gault near Dover."

Engineers, Junior Institution of, 39, Victoria-street, S.W., 7.30 p.m. Mr. H. E. Cosgreave, "Pneumatic Tubes."

Philological Society, University College, Gower-street, W.C., 8 p.m. Mr. D. Jones, "The Sechuana Language."

SATURDAY, MAY 5...Royal Institution, Albemarle-street, W., 3 p.m. Professor J. J. Thompson, "The Electrical Properties of Gases." (Lecture I.)

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FRIDAY, MAY 4, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, MAY 7th, at 4.30 p.m. (Howard Lecture.) WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Iron Ore Supplies." (Lecture II.)

TUESDAY, MAY 8th, at 4.30 p.m. (Colonial Section.) CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*, "The Problems of French North Africa." THE RIGHT HON. LORD BLYTH, Chairman of the Colonial Section Committee, will preside.

WEDNESDAY, MAY 9th, at 4.30 p.m. (Ordinary Meeting.) PROFESSOR WILLIAM RIPPER, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

"OWEN JONES" PRIZES.

The designs for this competition must be sent, carriage paid, and labelled "Owen Jones Prize Competition" on the outside, to the Director and Secretary, Victoria and Albert Museum, South Kensington, S.W. (7), between June 25th and 30th, 1917.

Full particulars of the competition were published in the *Journal* of December 8th, 1916.

HOWARD LECTURE.

On Monday afternoon, April 30th, PROFESSOR WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., delivered the first lecture of his course on "The National Shortage of Iron Ore Supplies."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, MAY 2nd, 1917; SIR ROBERT ARMSTRONG-JONES, M.D., F.R.C.P., F.R.C.S., J.P., in the chair.

The following candidates were balloted for and duly elected Fellows of the Society:—

Baker, Arthur, Denehurst, Darwen, Lancashire.

Datta, Gour Chandra, 19, Waverley House, Kenton-street, Russell-square, W.C. (1)

Field, Wilford F., Ivydene, Heston, Middlesex.

Ho Tung, Sir Robert, J.P., The Neuk, 83, Peak, Hong-Kong, China.

King, William W., Messrs. Typke and King, Ltd., Crown Chemical Works, Mitcham Common, Surrey.

Lim Peng Siang, 61, Kling-street, Singapore, Straits Settlements.

McKillop, Arthur Torrens, Ministry of Agriculture, Cairo, Egypt.

Patuck, Rustom Sorabji, The Vizianagram Mining Company, Chipurupalle P.O., Vizagapatam, Madras, India.

Shroff, Shiavaxsha Darabsha, Patel Mansion, Cumballa-hill, Bombay, India.

Smith, Robert Tweedy, 89, Chancery-lane, W.C. (2)

Vidyabhushan, Dr. Lingish (Shri Mahabhagavat), Ph.D., Kurtkoti, Dharwar, Bombay, India.

The paper read was—

HERB-GROWING IN THE BRITISH EMPIRE: ITS PAST, PRESENT AND FUTURE.

By J. C. SHENSTONE, F.L.S., M.P.S.

When the war commenced in 1914 we made the unpleasant discovery that herb-growing, which had been an interesting feature in our country life for upwards of a thousand years, had almost disappeared from the land, and that we had become largely dependent upon the Central European Empires for the supplies of

those medicinal and other herbs which had so long been produced by our own country-folk.

Herb-growing cannot, perhaps, be included amongst the largest industries, but as the very numerous minor and medium industries, added together, make a very large total, and as the profits derived by the Germans from the numerous small industries which they had appropriated made a very respectable contribution towards the funds which are being used to devastate Europe, I make no apology for asking the attention of the Royal Society of Arts to this commercially important subject.

The history of herb-growing is full of interest, and has a close connection with the social life of England; and, moreover, apart from its commercial importance, the inconvenience and trouble caused to those who attend to our sick folk was acutely felt at the commencement of the war.

Herb-growing in England undoubtedly dates back to the Roman period or earlier. Tacitus tells us that the climate of Britain is suitable for the cultivation of all vegetables except the vine and the olive, and the remains of plant life, found near Roman villas and buildings and identified by Clement Reid and others, afford sufficient evidence that a large proportion of the Roman herbs were cultivated by the Romans in these islands.

Saxon documents such as the Leechdoms, Wortcunning, Starcraft, and Glossaries of Early England, collected by the Rev. O. Cockayne and other authors, afford ample evidence of the interest taken in herb-culture by our Saxon forefathers. The Saxons were inspired in their herb lore by Dioscorides and by the Roman writers, and, as they added a plentiful crop of their own superstitions to those of the Romans, these documents are interesting reading to any with a taste for the quaint and curious. A hundred and twenty species of herbs are mentioned in Saxon records.

During the Mediæval period herb gardens formed an important feature in the gardens of the monasteries, and we have lists of the herbs grown in them.

But it was towards the end of the sixteenth and at the beginning of the seventeenth century that herb-growing arrived at its golden days in England. It was at this period that numerous bulky folio volumes, known as Herbals, were published, and to these England contributed its share. The most important amongst the English Herbals were Turner's Herbal (A.D. 1568); Gerard's Herbal (A.D. 1595), with a later edition by Johnson; and Parkinson's "Theatrum Botanicum" (A.D. 1640). Each of these volumes describes upwards of a thousand plants, and finds some use for most of them.

At this period botanists had no knowledge of the geographical distribution of plants, and expected to find in our island all Mediterranean plants described by Dioscorides and other classical writers. Hence much confusion arose; but Gerard knew his plants, and he has left us a list of some thousand plants which he grew in his garden in the Holborn.

The later Herbals became somewhat degenerate, but they appealed to the people, and served as a guide in their simple domestic medicine. Some of these contain critical references to the College of Physicians, which at that time represented the official medical practice.

Vegetable products commenced to arrive from the New World and from the remoter parts of the Old World at this period. Old English herbs were somewhat overshadowed by the attention of the medical practitioners becoming centred upon the investigation of the properties of the newer foreign introductions. This last period of herb lore may be said to have culminated, in my own younger days, in the production of a series of works by Pareira, Royle, Bentley, and Triman, Lauder Brunton, and others, one of the latest and best being the "Pharmacographia" by Flückiger and Hanbury, which still remains a standard work. The investigation of herbal remedies was now at its highest scientific development, chemists and pharmacists being busy investigating and isolating the active principles of herbs, and medical men in studying their medicinal action. At this period London was the chief drug market for the world.

But, again, new developments and new fashions arrived, serving to draw the attention of medical practitioners from the herbal remedies. The discovery of chloroform and the introduction of antiseptic surgery had given a great stimulus to surgery, and, scarcely less important, the science of bacteriology, founded by Pasteur, assisted in drawing attention from drugs, and it became an accepted doctrine that drugs did not cure diseases, but simply served to alleviate unpleasant symptoms. Nevertheless, the sufferers from acute rheumatic, neuralgic or internal pains, or other painful symptoms, have a poor opinion of the doctor who fails to give them quick relief, and, no doubt, by relieving painful symptoms much wear and tear incidental to illness is avoided. A fashion arrived from America for medicine in tablet form, and

later the synthetic chemical remedies came from Germany. These latter came so rapidly and occupied so much attention that herbal remedies were thrust into the background. A revival of the use of medicine obtained from animal sources, which formed a feature in ancient medicine, has also been recently developed, and "organo-therapeutics," as this branch of medicine is now called, has added some agents of very great value to our *materia medica*. At the present moment the science of bacteriology is occupying a very prominent place in medical research. But changes come rapidly, and though a number of the medicines in tablet form have established themselves in medicine, and a limited number of the synthetic medicines have come to stay, and no doubt both bacteriology and organo-therapeutics are likely to occupy a position of increasing importance in the medicine of the future, herbal medicines still retain a position in the affection of the people, and will, no doubt, once more attract a larger amount of attention from the medical world. Herbal remedies undoubtedly occupy a more important place in the medical and domestic practice in most European countries than they do with us at the present moment.

At the outbreak of the war the discovery was made that we had become dependent upon the Central Empires for both the supply of herbal medicines, formerly grown by us, and for those synthetic chemicals which have established themselves in medicine.

Before ending this historical section of my subject, I must refer briefly to the successful efforts which were made in the cultivation of cinchona bark towards the middle of the last century, and to the equally successful cultivation of the rubber plants, for these have an important bearing upon my subject. When, owing to the mismanagement of the cinchona forests in tropical America, we were threatened with a stoppage of the supply of quinine, an essential agent in combating tropical fevers and malaria, the Governments of India and of Holland made determined efforts to establish the cultivation of the best forms of cinchona barks. After encountering much obstruction and difficulty, these efforts proved completely successful, and resulted in the reduction of the price of quinine to about one-third of its former cost. In more recent times the advent of cycles and of motors caused a great shortage of rubber, and the cultivation of rubber was seriously taken in hand, with the result that the price has been much reduced, and although the synthesis of rubber has been very nearly completed, it is recognised that synthetic rubber would be more costly than that obtained from the rubber plant. On the other hand, one industry of India has been seriously injured, if not destroyed. The Germans expended a very large sum of money, and for many years employed a very large staff of chemists, to work out the synthesis of indigo, and were finally successful. But though much cheaper, the synthetic indigo is still inferior to the old vegetable dye, and the suggestion arises that if, during the time the Germans were working out the synthesis of indigo, we had spent a few thousands in a determined and systematic endeavour to cheapen the price of vegetable indigo by improvements in its cultivation and in its preparation, it might have been possible to save this interesting industry from complete extinction. It may not, even now, be too late to take steps in this direction. Tailors still regard the natural indigo-dyed cloth as the most permanent.

A frequent argument against the cultivation of plants has been that the collection of wild plants must necessarily be less costly than their cultivation; but the above examples serve to illustrate the fact that, when the cultivation of plants has been seriously taken in hand, the market price has always been reduced. Had the cultivation of the rubber plant been delayed, it is likely that the synthesis of rubber, commenced by Sir William Tilden and my late brother, would have been completed by the Germans, and our enemies would have then controlled the supplies of rubber during the war.

Present.

Immediately after the war commenced much trouble was caused to hospitals, dispensaries, pharmacies, and to medical practice generally by a threatened shortage of herbal medicines. Some of these were essential to the proper treatment of illness, some were not essential, but nevertheless their absence added to the trouble. This shortage was largely due to our having become dependent upon Germany, not only for the synthetic chemicals, but also for herbs which had in earlier times been cultivated in this country. Many of the medicinal herbs, the supply of which had been stopped by the war, were herbs which either belonged to our native flora or those which had been cultivated by us from early times, but the cultivation of which has recently been much neglected in England. Some of these plants are indispensable, as, for instance, belladonna (*Atropa belladonna*, Linn.),

henbane (*Hyoscyamus niger*, Linn.), foxglove (*Digitalis purpurea*, Linn.), colchicum (*Colchicum officinale*, Wiggers), and perhaps valerian (*Valeriana officinalis*, Linn.), and male fern (*Aspidium Felix-mas*, Swartz.). Others are of much value, but scarcely indispensable. Amongst these latter are dandelion (*Taraxacum officinale*, Linn.), poppy capsules (*Papaver somniferum*, Linn.), and chamomile flowers (*Anthemis nobilis*, Linn.). There are also many herbs which are used only occasionally in official pharmacy, and those required for veterinary practice and for culinary purposes. Amongst the culinary herbs are angelica (*Archangelica officinalis*, Hoffm.), borage (*Borago officinalis*, Benth. and Hooker), thyme (*Thymus vulgaris*, Linn.), the mints, and others.

A movement was quickly started to remedy this shortage of herbs, and served considerably to relieve the situation. It included both organised effort and private endeavour. The few remaining herb-growers at Mitcham, Carshalton, Hitchin, Long Melford, Market Deeping, and Wisbeach have no doubt speeded up their output. The National Herb Growing Association, a new organisation, supplied during the last season no less than a hundred tons of herbs, and county associations were also formed to assist in the work, whilst under the Central Committee for National Patriotic Organisation a confederation of county associations has been formed for co-ordinating the work in different counties. A school for providing instruction in drug-growing has been established at Chalfont St. Peter, in Buckinghamshire, by Mrs. E. M. Grieve. Lectures have been given by such authorities as Mr. E. M. Holmes and Professor Greenish, and much literature has been circulated. In short, a general movement has been made to revive this industry in England. But if herb-growing is to be permanently restored as a rural industry much remains to be accomplished, and under the conditions which will follow the war the situation will again be changed and the work require revision. We may then have to compete once more with imported drugs, and continued success must depend upon careful economic organisation. But this leads to the third and last section of my subject.

The Future of Herb-growing in the British Empire.

A frequent argument which has served to discourage herb-growing in the past is that the labour involved in herb-cultivation would bar success when competing against the collection of wild plants. But when we look into the matter, we find that in every case when cultivation has been seriously undertaken and persisted in it has ultimately driven the wild plant from the market. I have already referred to two notable cases of recent times among very many examples; a few others must serve my purpose. Some three centuries ago the cultivated strawberry was simply our wild woodland strawberry transplanted to the garden: a comparison of our modern strawberry with the wild strawberry affords a fair example of the changes which can be produced in plants under cultivation. On the other hand, the vegetable sea kale, which was first cultivated in the earlier half of the last century, has been very little changed by cultivation; nevertheless the wild plant never appears in the market. In fact, every cultivated plant had in its early days to compete with its wild form, and in every case where the cultivation of plants has been seriously undertaken the cultivated plant has driven the wild plant out of the market. But the success of any endeavour to restore the cultivation of herbs in this country will depend upon careful and continuous attention to scientific culture and economic organisation. Half-hearted measures will only lead to failure.

The collection of wild plants for industrial purposes is subject to one great disadvantage: it is destructive, and unless carried out upon a very small scale the source of supply *has invariably been quickly exhausted.* I can take you to localities in our chalky counties where belladonna has been almost destroyed, and this at a time when we depended mainly upon the Central Empires for our supplies. We shall see later that this fact was being recognised by the Governments of the Central Empires, which had recently established experimental farms for perfecting the cultivating of herbs.

But, apart from the danger of exhausting the supplies, the wild plants not only vary considerably in the qualities for which they are valued, and in this respect remain stationary, whilst by continuous scientific cultivation there appears to be no end to the changes which can be produced in plants, rendering them of greater service to man. It is only necessary to glance at our fruit and flower shops, and compare the fruits and flowers there displayed with the wild plants from which they were derived, to be convinced of this fact. I will endeavour to show how the improvements of cultivation might be applied to some of our medicinal herbs.

We have learnt that the alkaloidal value of cinchona bark was greatly raised by cultivation. Henbane and belladonna are both herbs the shortage of which has caused us much trouble, and we have not yet completely remedied this shortage. The market value of both these herbs is determined by their active principles. It is pretty certain that the alkaloidal value of both might be considerably raised without increasing the cost of production; but for this purpose the co-operation of the chemist with the culturalist would be required. As a fact, the greater price which has to be paid for English henbane than was formerly paid for the imported German herbs is compensated for by the greater richness of the former in alkaloids. Henbane is very capricious in its growth, refusing to germinate in some places, and the crop varying without any apparent reason. Naturally the few successful growers do not disclose the condition and treatment necessary to secure a fairly certain crop. Having spent time and money in gaining the experience, they naturally leave it to others to learn by the same process. In some maritime localities it can be grown without any trouble.

Digitalis is a herb whose value depends upon two active principles, slightly differing from each other in their physiological action. Hence it is usually standardised by a physiological test. I recently noticed the advertisement of one of our oldest firms of herb growers offering standardised digitalis of a high physiological value. That is a step in the right direction. A medical friend who collected his own digitalis and prepared his own tincture told me that he found that foxglove growing on a hot sandy bank, protected by a wood, gave him the best results. It was stated at a recent meeting of this Society that the wild foxglove of this country would supply all the requirements of our drug market. But wild foxglove not only varies much in its medicinal value, but experience has shown that persistent destruction, without taking steps to replace that which has been taken away, invariably ends in the extermination of our wild flora.*

The oils of lavender and mint produced in this country far exceed in delicacy and flavour those produced by any other country, and are quoted in the drug lists at three or four times the price of the best of the latter, even after they have been submitted to processes of redistilling and of refinement. But much larger quantities of foreign than of English are consumed on account of their cheapness. The problem here is to obtain a strain of lavender and mint plants which would yield larger quantities of oil in our climate. Lavender plants might be produced bearing many more florets upon their spikes, thus reducing the cost of culture and harvesting. Also, economy of labour in harvesting and distilling should be studied. During the last forty years horticulturists, in endeavouring to satisfy the public demand for beauty of form and colour, have almost succeeded in producing a great number of varieties of roses without scent. It is possible that this process might be reversed in the case of lavender and the mints, and that varieties yielding a more abundant supply of essential oils might be secured by persistent endeavour without reducing our English standard of refinement. If our English oils could be reduced in price they would replace the foreign to a greater or less extent, depending upon the reduction in cost of production.

The appearance of drugs may influence their market value, more particularly those intended for domestic use. It is very doubtful whether the double chamomile flowers serve the purposes for which they are used any better than the single flowers. Yet the double flowers formerly supplied by Belgium are more in demand than the single ones.

In former days dandelion juice was a favoured preparation, both in official and domestic medicine. Provincial druggists sent their collectors for the roots, and expressed the juice whilst these were quite fresh. Many country druggists prided themselves upon their dandelion juice. When the preparation of the herbal medicines migrated to the great centres, the undried roots deteriorated before being received at the factory; hence the fresh juice was replaced by an extract from the roots which had been dried as quickly as possible after being collected. Experiments in producing the most active dandelion juice would be worth consideration.

Another feature of the subject deserves consideration. In our drug price lists we find a good many herbs which, though they have never been cultivated in England for medicinal purposes, would be well worth experimenting with, in order to extend the field of English herb-growing. Amongst these are the roots of the gentian (*Gentiana lutea*, Linn.). Preparations of the roots of this plant are in constant use in every dispensary. The plant is indigenous

* What happens in practice is that the collector draws his supplies from one wood until he has exterminated the plant, and then proceeds to the next wood conveniently situated, until a considerable area of destruction has been accomplished. We must not forget that it requires several pounds of fresh herbs to produce one pound of dried herbs.

in Central Europe, but Miss Willmott tells me that it can be quite easily grown from seed in England, and that she grows it in her gardens at Warley Place quite as luxuriantly as in its native country. In earlier times medical men used a much wider range of bitter herbs, varying them to suit the other ingredients in their mixtures or to suit the special needs of their patients. Fœnugreek (the seed of *Trigonella fœnumgræcum*, Linn.) is now imported from India, Egypt, and Morocco, but was grown in English gardens in the sixteenth century. It was formerly used as fodder for cattle. Its seed is specially relished by horses and cattle, and it is an important ingredient in the condition powders given to animals when they are off their feed. If the price could be reduced by cultivation in England or in some of our Colonies, and brought within closer range of ordinary foods, might it not be of great value to farmers for rendering less palatable food more acceptable to animals at seasons when fodder is scarce?

Liquorice, extracted from the rhizome of *Glycyrrhiza glabra*, Linn., is grown in Yorkshire on a small scale, but most of our supply comes from Spain and Italy. The English extract, sold in the lozenge form and known as Pontefract cakes, has a much more refined flavour than that imported. This herb could also be cultivated in Essex and Surrey. The extension of the cultivation of this herb is desirable. Saffron (the stigmas and tops of the styles of *Crocus sativus*, Linn.) was formerly grown at Saffron Walden, in Essex. The best now comes from Valentia, in Spain, but Austria, Italy, and France also produce it. It is used as a flavouring for cakes, saffron cakes being still popular in the West of England, and they certainly afford a pleasant change from the familiar cakes of the London bakeries. A demand has also arisen for it as a specific for measles. "Please, sister has a touch o' measles. Muvver wants a pennorth o' saffron to bring out the spots," is a frequent demand made to pharmacists in the crowded parts of large towns, and when an epidemic rages the order is a very frequent one. The plucking of saffron stigmas might be organised to provide a welcome breath of country air to London children, batches of whom might be taken to the country by kind town workers. Alkanet root (*Alkanna tinctoria*, Tausch.) comes chiefly from Hungary; it is used for staining woods, colouring oils, etc. It was formerly grown in England. The rhizome of orris (*Iris florentina*, Linn., *Iris pallida*, Lamarck., and *Iris germanica* Linn.) is much used for children cutting their teeth, and its powder forms a frequent flavouring to tooth powders; it is also used much in perfumery. *Iris germanica* and other irises are cultivated in this country for their beautiful flowers, but no attempts have been made by us to supply the market with the rhizomes. To succeed in this it would be necessary to secure a form which would yield a good odour and flavour when grown in England. Sweet flag or calamus (*Acorus Calamus*, Linn.) has become a wild plant in England, but the rhizomes are imported from Holland and Germany for commercial purposes. Cummin fruit (*Cuminum Cyminum*, Linn.) will ripen its fruit as far north as Norway; it could be cultivated in England, but we get our supplies from the Mediterranean. Cummin is used in curry powders and in veterinary medicines. Juniper berries are from a plant which grows wild in England, but the berries of commerce are chiefly from plants cultivated in Hungary. *Scopola carniolica*, Jacq., a common plant in Austro-Hungary, Bavaria, and South-West Russia, which yields the alkaloid hyoscine (*Scopolamine*) so much used by eye surgeons and in some other branches of medicine, appears in our trade lists of plants recommended for our pleasure gardens. By selective cultivation its yield of alkaloid might be raised.

From the northern parts of the American continent we import many very valuable drugs, some of which are not unsuited to our climate. The following may serve as examples: *Gaultheria procumbens* (wintergreen) may be seen flourishing in English pleasure gardens. Varieties of *Prunus virginiana* (*Prunus serotina*, Ehrh.), which species yields us the bark popularly known as wild cherry bark, are grown as decorative trees with us, but we import the bark. *Lobelia inflata*, Linn., and *Hamamelis virginiana*, Linn., have both appeared as ornamental plants in England, the latter having had a place in our gardens for many years, and is much used in pharmacy, but is imported for this latter purpose. *Podophyllum peltatum*, Linn., yielding one of the most valuable of modern medicines imported from the American continent, also figures in our garden catalogues as a decorative plant. *Hydrastis canadensis*, Linn., a native of Northern United States and Canada, has been cultivated in our gardens; but it is stated not to succeed for commercial purposes under cultivation, nor do we specially desire to rob our Colony of one of its natural products. The herb yielding santonine is an almost indispensable drug, which is imported from Russia, its price at the present moment being

almost prohibitive. This herb (*Artemisia maritima*, Linn.) is common upon some parts of our coast. I am not aware that any investigations have been made to ascertain the value of our native plant, nor of any attempts to introduce the Russian variety (*V. Stechmanniana*, Besser.).

We still depend upon Northern China for that important drug, rhubarb (*Rheum officinale*, Baill., *R. palmatum*, Linn., and probably other species). That grown in the English climate in Berkshire does not command a high price in the markets, although its medicinal properties are the same as those of the Chinese roots. The English growers should try again, and endeavour to produce a more marketable root by experimenting with different soils and methods of cultivation. Possibly the English roots are not so old when harvested as the Chinese, and not so carefully trimmed for the market.

We must now consider the organisation necessary for retaining and extending English herb-growing in the future. Those who patriotically came forward at the commencement of the war to ease the situation had little experience either of herb-growing or of the drug trade. At first their arrangements were necessarily rough and ready, and they had many difficulties to encounter; but they have gained much experience as their work proceeded. After the war the trade will have once more to contend with foreign competition, and whether this country decides to open its markets to foreign traders whose own markets are carefully protected by heavy import duties, or whether we modify our fiscal system, it will still be necessary to perfect our organisation for successfully establishing English herb-growing. Many of the protected countries have the additional advantage of experimental herb farms. The Ministry of Austria has recently established experimental farms for perfecting the cultivation and preparation of herbs near Vienna and Prague. In Hungary this trade was in a more advanced state, and experimental farms had been established for a considerable time. There the cultivation by school children, under the superintendence of school teachers, has been well organised. In Sweden efforts are being made to popularise herb-growing, and in the United States of America and Canada experimental stations also exist. In all these countries the advantage of fostering such industries by the State has been recognised. It is evident that to compete with well-organised foreign competition it will be necessary to establish an organisation not only as good as, but if possible better than, that of our competitors. It will be necessary to have experimental central stations, where stocks of best seeds and plants can be raised by selective and other cultural methods—methods which have succeeded so well and produced such great results in our other horticultural enterprises. These seeds and plants should be distributed to our country-folk and villagers, and their plots inspected and advice given during the growing season.* The centres should be provided with drying sheds for dealing with such drugs as cannot properly be dried by the small growers, and these should be so situated that such herbs as the dandelion root could be delivered before deterioration has set in. Distilling plant and plant for extraction might be found desirable, and, perhaps more important, an analytical laboratory for estimating the active constituents. The centres would also serve for collecting and marketing the herbs. A really effective herb-growing organisation might require nurturing in its early days by the State or by patriotic capitalists. Probably some of our present herb-growing ventures would bring their present undertakings into line with the new necessities.

A further extension of this wide subject must now be referred to. There is a peculiarly unsettled part of the world from which we draw supplies of several most useful herbal products. I refer to the Balkans, and to Turkey and Eastern Mediterranean countries. The frequent political troubles which arise in those parts have been the cause of much inconvenience to our manufacturers by the stoppage of supplies. Amongst these products I may instance otto of rose, indispensable in perfumery and also used in medicine. This is obtained from the damask rose (*Rosa damascena*, Miller), and is a monopoly of Turkey and Bulgaria. The methods of production are crude—they owe their monopoly simply to soil and climate; but surely in our wide Empire, embracing such a wide range of soil and climate, we can find some spot where this delightful product can be produced of equal quality, and thus render us independent of these unsettled people.

Gum tragacanth, a most valuable gum, is produced in Syria from *Astragalus gummifer*, Labill. Expensive at all times, it becomes almost unobtainable when trouble arises. Could we not find a district somewhere in our Empire which would produce this valuable gum in greater

* This system is essentially similar to that which has for a very long period been carried out in this country with great success in the production of flower seeds and vegetable seeds.

quantities than are at present obtainable? The indispensable acacia gums, obtained from *Acacia Senegal*, Willd., and other species, which are wild in North Africa, are other products the supplies of which have been stopped within my own experience. Might not these gums receive attention, and larger supplies of the best varieties be produced within our Empire, or is it necessary to wait until the gum-producing forests have been exhausted? Our stock of storax from Western Asia Minor has been exhausted, and the formula for one much-valued official preparation will for the time have to be changed. If not a catastrophe, this is at least an undesirable event. Aniseed, from *Pimpinella anisum*, Linn., is cultivated in the Eastern Mediterranean district, and squills, from *Urginea Scilla*, Steinh., which is a constituent of most cough medicines, also comes to us from the Mediterranean districts. Galls of value both in medicine and to dyers and ink-makers, which produce a much more permanent black than the synthetic productions, come to us from Asia Minor and Persia. Turkey opium from *Papaver somniferum*, Linn., is still richer in valuable alkaloids than any other variety of opium. Could not opium of equal value be produced in some of our very wide range of climates? Mastic (*Pistacia lentiscus*, Linn.) is from Mediterranean countries. It is used as a temporary stopping for teeth. It was formerly highly valued by varnish makers, but owing to its high price it has been replaced by cheaper resins, being now only used for picture varnishes. If the cost could be reduced by better methods of cultivation and collection, would it not again find a place as an ingredient in some of the higher qualities of varnishes?

Myrrh (*Balsamodendron Myrrha*, Nees.) is from S. Arabia and N.E. Africa. It always arrives much mixed with other gums, and much expense is entailed in its separation by hand-picking. Insect powder is produced from *Chrysanthemum cinerariæfolium*, Montague, and provides a much-esteemed powder, that from Persia being of less value. This plant can be grown in England, but how the quality compares with that grown in Dalmatia I cannot say. Experiments should be made to discover in which part of our Empire this herb can be produced in the greatest perfection. But space will not permit of my dealing with all the products of these Eastern countries. There appears to be some danger that our Colony of Malta may suffer from severe depression after the war, and it was suggested at a recent meeting of the Linnean Society that it might be well to try to restore prosperity to our island by using it to the utmost for growing such of these Mediterranean medicinal plants as are suited to its climate.

If we extend our vision and inquire into the products at present grown in tropical countries outside our own Empire, but which might be produced by our own people, the subject takes a very large aspect. To appreciate this, we need only to consider the great wealth extracted by the Dutch from their one small group of tropical islands, which includes Java. The Dutch use these islands for all they are worth, producing the finest cinchona barks, rubber, coffee, and the finest spices of all kinds—in fact, everything of value which their tropical countries can produce. Nowhere in our wide stretches of tropical lands can we show results equal to those obtained by our neighbours the Dutch. If we made full use of our wide range of soil and climate we might do much to replace the wealth expended upon this war.

Possibly the bulk of ginger (the rhizomes of *Zingiber officinale*, Roscoe.), supplied by our grocers comes from China, though the ginger provided by our Colony Jamaica is of far finer quality, and would displace that of foreign origin if it could be reduced somewhat in price. Zanzibar cloves (*Eugenia caryophyllata*, Thunb.) are stated to be of the lowest market value; if this is so, efforts should be made to raise their quality. But the treatment of tropical economic plant life is too large a subject for adequate treatment in this paper.

In conclusion, I do not apologise for troubling you about the many little things included in this paper, nor for having confined my remarks to the little things connected with one industry. It is obvious that when we add together the little things of the world's commerce, or even the little things of economic culture, they mount up to a very big total. Our enemies in Central Europe had appropriated a large portion of the little things of the world's manufacture and commerce, and we are told they were also making headway in attacking the large things. I trust that in our reorganisation both large and small things connected with our vegetable products will receive full attention, with a view of getting the best results we can out of our big Empire, with its fine range of soil and climate. I might suggest that the Imperial Institute, which has accomplished useful work, might be reorganised and speeded up, and that our botanical gardens at home and in our Colonies could greatly extend their work in the economic departments.

A Government Department might be entrusted with funds for the encouraging and developing of the soil of the British Empire. Recently a very big sum has been spent to value English land with a view to redistribution of taxation. If it is good economy to spend so large a sum in order to take money from one pocket and place it in another, surely it would be still better worth while to spend a few hundred thousand to encourage the use of our wide dominions to their utmost, and to encourage our manhood to speed up and give us their best in times of peace, as they are doing during the times of war, and incidentally to enlarge the resources from which necessary taxes could be raised without overburdening the people. In private enterprise modern men look for a reasonably quick return. They hesitate to invest large sums on the chance of other people's grandchildren reaping a benefit. The State should have a more distant vision. The life of a State far exceeds the life of a few generations of men. Hence some industries, such as the tilling of the land, should be to some extent encouraged and controlled by the State, whose duty it is to conserve the interests of later generations and to minimise the risk of suffering caused by such times of stress as those we are at present experiencing.

The commercial side of herb-growing must not be quite overlooked, and in considering this side of herb-growing we must not overlook the considerable export trade to our colonies and other countries, which should be added to our home consumption of drugs, if we succeeded in reviving this industry. Whilst the synthetic chemicals, which have formed such an important feature in the pharmacy of recent years, have come from Germany, one cannot avoid noting that America has supplied us with most of our new herbal medicines, and this in spite of the fact that our own Empire has a far more varied and numerous flora. The following will serve as examples of the American herbal remedies which have found a place in pharmacy during the last fifty years: Podophyllum (*Podophyllum peltatum*, Linn.), introduced in 1864, Gaultheria (*Gaultheria procumbens*, Linn.), wild cherry bark (*Prunus serotina*, Ehrh.), caulophyllum (*Caulophyllum thalictroides*, Linn.), cascara sagrada (*Rhamnus Purshianus*, DC.), hamamelis or witch hazel (*Hamamelis virginiana*, Linn.), gelsemium (*Gelsemium nitidum*, Michaux), euonymin (*Euonymus atropurpureus*, Jaquin.), and very many others.

Both Americans and Germans have proved themselves great experts in marketing the goods they produced. The Germans were not content, having synthesed new chemicals, to wait till chance customers came along, but experimented to discover every purpose for which their new chemicals or waste products could possibly be used. They then flooded our country with carefully trained commercial travellers to force their wares upon all whom they were likely to interest. Thus their scientists, their manufacturers, and their commercial men all pulled together. The Americans have also proved themselves experts in marketing their wares, and doubtless their scientists afforded the necessary assistance in turning their products to commercial purposes.

There can be no doubt that there are very many herbs in our own wide Empire, and some in England, which would yield medicines of as great or greater value than those imported from foreign countries if our medical men would give some attention to this important branch of their work, and, in combination with pharmacists and botanists, investigate the plants likely to be fruitful in results, and would assist the commercial men in securing proper consideration for those which proved of value, instead of relying so much upon foreign countries for the advances in *materia medica*. This should be possible without any neglect of those other important branches of medicine which have yielded valuable results. It is also possible that if our average general practitioner cultivated a wider knowledge of *materia medica*, as in former days, the modern habit of using proprietary medicines, or medicines recommended by unqualified persons, might recede into the background. The public are apt to become quite familiar with the limited range of a doctor's stock medicines, and in consequence to try to get relief from the often troublesome symptoms of minor complaints, by hunting round for medicines without seeking the guidance of their medical man. Herbal remedies are much more widely employed throughout Europe than in England. It might possibly be better for us if we made larger use of the more natural and milder herbal medicines, and discontinued the often too frequent use of the more drastic salts, so much used in this country.*

* It appears to be impossible that the German mineral water springs could have produced the great bulk of so-called natural mineral waters with which Germany flooded this country before the war. It is generally believed that much of this water was artificially prepared, and that it might have been equally well prepared in England, and the large revenue resulting in the trade kept in this country.

A much closer sympathy and better understanding between all departments in our wide Empire should be cultivated if in the future we are to realise its full strength. We must learn to think and act imperially in great things and small, and reorganise with a determination to get the best out of our Empire, without neglecting to be true neighbours and friends to our brave Allies and such neutral countries as will enter into neighbourly bonds.

DISCUSSION.

THE CHAIRMAN (Sir Robert Armstrong-Jones, M.D., F.R.C.P., F.R.C.S.), in opening the discussion, said he was sure all present would agree that the paper was extremely interesting and instructive. The author had referred to the useful work of the Herb Growing Association, and also to the greater and wider use that might be made of our vast Empire, and he personally thought that now was the time to act. He believed that what was initiated now would be really the keystone of after the war reconstruction. There was an opportunity of growing in this country, or at any rate in the British Empire, a great many herbs that had been previously obtained from enemy countries, in consequence of which a shortage was now being felt. There were from eighty to one hundred medicinal herbs, shrubs, trees, and plants of medicinal value. The author had referred to about forty of them, but the others could practically all be grown within the Empire. In former days in the country districts medicinal herbs—such as wormwood, chamomile, mint, sage, and thyme—were collected and dried by the people in their own houses, but now the chemist seemed to have taken the place of the still-room. The tabloid form of synthetic drug had largely replaced the medicinal herb, and he thought the effect of veronal and other such drugs was much more harmful to the patient. As the author had said, there were many difficulties in connection with the harvesting and drying of herbs, and also the want of businesslike acumen on the part of those who were in charge of the matter made it difficult for people to take an interest in it. For example, his own family last summer collected many pounds of digitalis and raspberry leaves and sent them to the Herb Growing Association, but so far they had not received anything but a formal receipt. Many efforts had been made at different times to encourage the cultivation of herbs in this country: for instance, a herb garden was started at Chelsea in 1666, the Royal Society of Arts in 1763 started the growth of rhubarb and the opium poppy, and the cultivation of medicinal herbs was commenced at Mitcham in 1756. He was glad to see that the Herb Growing Association had issued an instructive leaflet with regard to the matter, because he thought that ignorance as to the kind of soil required, as to the time of harvesting and as to the drying, accounted in a great measure for the decay in the cultivation and use of medicinal herbs. There was at the present time a great scarcity of gentian and valerian, and also a considerable shortage of digitalis, belladonna and scopolamine, while the Government had commandeered all quinine and phenacetin.

SIR GEORGE HENRY SAVAGE, M.D., F.R.C.P., as the representative of the College of Physicians on the governing body of the Physic Garden at Chelsea, said that that garden was limited in its scope at present; it was not a garden for the growing of herbs, but was rather for the instruction of those who wished to know something about botany, and it also provided for the education and examination of those working at botany. He had nothing to say about the practical growing of herbs, but herbs and herbals were closely related, and there was a great deal of interest in the herbals, such as those of Gerard, Salmon, Parkinson and Culpepper, although in many cases they were very difficult to follow. There seemed to be a fashion in drugs as in other things. Recently he had had an inquiry as to whether the British bedstraw was a useful herb, and he had replied in the negative, but on looking up the *British Medical Journal* of some forty years before he found that bedstraw was efficacious in certain cases. The author had omitted to mention jalap in his list of herbs grown in England, but he (the speaker) had known it to be grown in Hampshire and also in Norfolk. With regard to the survival of the use of medicinal herbs in some parts of England, when he was practising in Cumberland some fifty years ago the people there used many kinds of simple herbs, the remedies that one man in particular made from gentian and dandelions and such plants being really very efficacious. A Fellow of the Royal College of Physicians had warned him to be careful in the choice of herbs to be cultivated, and asked him whether he was growing herbs such as were required by the British Pharmacopœia or herbs that would be taken not by the qualified practitioner but by the herbalist. That, of course, was an important point. He might point out that a man not generally reputed to be a botanist—Rousseau—wrote a book on botany in which he did not agree with the herbalist, for he said in the introduction: "The fault or misfortune of botany has been that it has not been studied as a science, but it has been studied by those doctors who merely want to get remedies for the cure of disease."

MISS A. SANDFORD said the response to the appeal of the National Herb Growing Association, started as a patriotic endeavour to meet the shortage of drugs, was so enormous that the Association found itself embarked on a much larger enterprise than it had contemplated. It tried to develop its work on patriotic, educational and

commercial lines. Many school teachers were very glad to have some object for the botany they had always been obliged to teach; the children were shown the plants in the fields, and collected them under supervision, so that no destruction should take place. The Association soon saw that unless its work was placed on a proper business basis it would not succeed. The war had provided a unique opportunity for getting back the trade into this country, and there seemed to be a very good chance of keeping it there.

SIR WILLIAM GREY-WILSON, K.C.M.G., wished to speak on the practical side of the question, which, as far as the commercial aspect of the matter was concerned, was the vitally important one if this country was to hold its own after the war. He thought that the Board of Agriculture did not give the help and encouragement that it ought to give in regard to the subject, and which were freely given to him on many occasions by the Agricultural Department in America. The Board of Agriculture had issued a leaflet with regard to the cultivation of medicinal herbs, and in their revision of that leaflet in the previous year they strongly urged that everybody should grow herbs as a patriotic undertaking. In a recent number of the *Board of Agriculture Journal*, however, they contradicted nearly all they had said in that leaflet, and said there were only four herbs of medicinal value, namely, belladonna, henbane, digitalis, and colchicum, the supplies of which, they said, were quite adequate at present. In reply to that the National Patriotic Organisation, which was the godfather of the National Herb Association, published a letter in the *Field*, in which they attacked the attitude taken up by the Board of Agriculture, and dealt with many of the points that had been raised. The Board of Agriculture ignored the important question of whether this country could not after the war replace Germany and Austria and other foreign enemy countries in the supply of drugs for medicinal purposes; and they also ignored the existence of the Colonies and the consumption of drugs in them. The National Herb Federation had been requested by the Food Controller to confine its attention to the production of food, and that had therefore been its aim. They had endeavoured to confine the interests and efforts of the Herb Federation centres, of which there were some sixteen or seventeen in this country, to the production of food for the time being.

MISS E. G. WHEELWRIGHT, speaking on behalf of the Herb Growing Association, with which she had been more or less closely connected since its formation fifteen months ago, said that the Association commenced its work as a patriotic measure to relieve the shortage of drugs which could be and once were cultivated in this country, especially those mentioned by the Board of Agriculture, namely, belladonna, henbane, digitalis, and colchicum. The Association now had over 3,000 members, growing herbs not on a very large scale but in gardens and allotments. In order to guard against the destruction of the native crops, a recommendation had been issued to the members to put back a piece of the root of the plants they removed. The Association had had a great many difficulties to contend with, including the burning down of its first drying shed. With the advice and help of the members of the Pharmaceutical Society, they had tried to teach people how to dry the herbs for themselves, and sent out in the previous year one hundred tons of dried stuff to the manufacturing druggists of the country. They wanted to go beyond herb drying, and begin vegetable drying and fruit drying. Their new machine at Chalfont St. Peter would probably be a great success, and they hoped at the end of the year to have very good results to show from their work.

MR. R. C. WREN said that if, as had been stated, we were a thousand years wiser to-day than we were before the war, he did not think that was the case in connection with medicinal herbs. In this country doctors were using very few of those herbs, and it was only by adopting the methods of the American commercial traveller that doctors could be made to see what the value of English herbs was. He thought the time had come when all the medicinal herbs in this country should be properly examined by scientific examiners, and that the doctors as well as the chemists might well turn their attention to them. He could confirm the remarks made by a previous speaker as to the extensive use of medicinal herbs by the common people in various parts of the country. He would like to turn the attention of those people who were cultivating medicinal herbs to culinary plants also, such as sage, parsley, thyme, and mint. After visiting the Board of Agriculture botanical farms in different parts of Nigeria he had made several suggestions as to what might be grown on the West Coast of Africa in the way of medicinal plants, but he thought it was important now to concentrate attention on the growing of herbs in this country. He would be glad to give advice to anyone interested in the subject, if they would address letters to him, to the care of the Secretary of the Royal Society of Arts.

MR. E. M. HOLMES (Curator of the Pharmaceutical Society) said that the press in many instances seemed to regard the cultivation of herbs as a "fad," but that was not correct, and in Germany, the United States, Japan, and other countries, a great deal of pains had been taken to point out what could be done in the cultivation of medicinal plants, and how they could be improved. The Government had said that there was no shortage of such things as digitalis, but in the drug market that morning there were specimens of digitalis from Spain being shown, of which ten tons had been sent over here, and if there were no shortage

of it in this country that Spanish digitalis, which was inferior to the English digitalis, would not have been imported. There was no doubt that the shortage since the war commenced of some of the most important herbs used in orthodox medicine, such as belladonna, henbane, foxglove, colchicum, chamomile, and valerian, was due to the fact that they had been previously supplied, usually of inferior quality, from the Continent, at prices with which the British cultivator could not compete. Although all those plants grew wild in this country, their collection was hindered by the operation of the game laws, as landlords objected to their collection in the woods and fields where they grow, and took no steps to extend the area where the plants occurred. The factors that would lead to a large and successful herb industry after the war was over were, in his opinion, first, a protective tariff enabling this country to compete on equal terms with the foreign herbs, offering a better article at the price than other countries did; and, secondly, a grant from the Government for scientific investigation in the improvement of the best strains of each plant by careful selection and cultivation. That grant might be given to each agricultural college where herb cultivation formed a part of the education. The factors regarding the collection of wild herbs in this country were, first, the utilisation by large landowners of suitable uncultivated woods and lands where the plants were known to flourish; secondly, the erection of suitable drying sheds; and, thirdly, organisation by capable workers of the children of the elementary schools as collectors. With regard to the cultivation of herbs in the Colonies, in South Australia the menthol plant, which was first introduced by the Germans from Japanese sources, was being grown.

Professor Henry George Greenish said all those present wished to bring back to this country from the Continent of Europe the old industry of herb-growing, and possibly also to realise that higher ideal—that the British Empire should supply everything that the British Empire needed. Some years ago an experimental drug station was established in Hungary, under the control or part control of a drug expert, and then about six or seven years ago Austria woke up to the fact that Hungary was doing a large business and had experimental stations in three different cities, and therefore she established two experimental stations on the Hungarian lines, *i.e.* under the control or part control of a drug expert. The object of these stations was to determine the conditions under which the different plants could best be grown, the trial of different forms of drying apparatus, and the formation of classes for those interested in the subject. Germany was now contemplating the establishment of such experimental stations on the same lines, and he thought if we were going to make any real progress we should have to adopt a similar method. We ought to see that our stations were financially independent. Anyone who wished to grow herbs should be able to make application to the experimental station and receive the necessary cultural details, which professional herb-growers, who had spent much time and money on the subject, could not be expected to reveal. The stations in the Colonies—at Ottawa, for instance—were mostly interested in agricultural problems rather than in the cultivation of drugs, and if we wanted to take up the drug question it was essential that we should have a drug expert in control or part control of the experimental stations. The author had alluded to *hydrastis canadensis*, but two plants—one a very common one—had recently been recommended as being capable of replacing that to a certain extent, and he thought the matter required further investigation. It showed that there were possibilities in the wild plants of our own country that were not yet developed. Some time ago, when active principles were extracted from drugs, doctors had the idea that they had only got to get that active principle and administer it in small doses and it did not matter where they got the plant from, but he thought a change was coming over the medical profession in that respect. It had been shown recently that the rate of diffusing those active principles from a simple preparation was very different from the rate of diffusion when it was in the form in which it existed in the plant, and he would not be surprised if doctors came back to a very considerable extent to the use of preparations of drugs and not of the active principles that were extracted from those drugs. The Research Laboratory of the Pharmaceutical Society was about to take up the question of whether there was any advantage in the use of double chamomile flowers rather than the single, and also the question of whether a preparation of dandelion root could not be made which would preserve the active constituents in the state in which they existed naturally in the plant—then they would be able to have that preparation administered to see if it produced any important medicinal effects. He thought ultimately our knowledge of medicinal plants in this country would be very materially increased, to the general benefit of the people.

Mr. Alfred Wolfe said, with reference to the Chairman's statement that no proper acknowledgment or report was made on the exact value of the herbs sent to the Herb Growing Association, he must ask forgiveness for that and ask those present to accept the fact that the Association believed the best thanks was the gratitude of the country for the efforts that had been made. With regard to experimental drug stations, he thought they should not be made State institutions. He believed that the proper direction of the herb-growing industry on co-operative lines would do as much as anything else to re-establish the industry. The Herb Growing Association hoped to work on

the lines of co-operation between the growers and collectors, and possibly also the purchasers of the herbs; and to establish a chain of drying sheds throughout the country to which herbs might be sent from the surrounding districts. He would like to utter a word of warning against the feeling that the herb-growing industry was a matter only for the large grower, because the small growers also should be encouraged to cultivate herbs.

Mr. F. A. Hocking thought the growing of a large variety of herbs was a waste of time. The only drugs needed were three—belladonna, digitalis, and valerian. It was not the belladonna root that was required, but the atropin obtained from it, and if a cheaper source of supply for atropin was discovered they were going to get it from that source. If drugs could be produced within the Empire there was no need to trouble about producing them in England itself. A committee of medical men should be formed to make a list of the drugs of a medicinal character which they could really use. With regard to the shortage of drugs, he might say that he had been able to obtain gentian and English hyoscyamus without any difficulty. The shortage that did exist was probably due to the fact that large quantities of drugs had been exported from this country to the Allies. It had been said that medical men did not try various herbs, but as a matter of fact they did. In his dispensary at the London Hospital he had half a room set apart as a museum of things that had been tried and found wanting. They had also a pharmacological laboratory in which drugs were tried by experiment.

On the motion of the Chairman a hearty vote of thanks was passed to Mr. Shenstone for his interesting paper, and the meeting terminated.

OBITUARY.

Henry Benjamin Wheatley, D.C.L., F.S.A.—Many of the Fellows of the Society will receive with much regret the news of the death, on April 30th, of Mr. H. B. Wheatley, who was for so many years Assistant Secretary of the Society. He was born on May 2nd, 1838, and was the posthumous son of Benjamin Wheatley, a well-known auctioneer in Piccadilly. His mother also died when he was quite young, and he was brought up by his eldest brother, Benjamin Robert Wheatley, the Secretary of the Royal Medical and Chirurgical Society and a bibliographer of considerable repute. Henry Wheatley was educated almost entirely by this brother and an elder sister, and his early years were consequently spent in a literary and bibliographical atmosphere. It was natural, therefore, that he should soon turn to matters connected with books and letters, and at an early age he was associated with his brother in work like that of cataloguing the library of the Athenæum Club. He also prepared the catalogue of the library of the Oxford and Cambridge Club. Work of this sort led to his appointment as Clerk to the Royal Society in 1861 under Walter White, who was Assistant Secretary from 1861 to 1884. His principal work at the Royal Society was connected with the library, and he was practically the librarian. In 1879 he was appointed Assistant Secretary of the Society of Arts, and, as all connected with the Society are well aware, he discharged the duties of the post with efficiency and capacity, until advancing years led to his retirement in 1908.

In spite of the pressure of his official duties at the Royal Society and the Society of Arts, he found time for the production of an enormous mass of literary material—all of it sound and useful work, and a great deal of it of real and permanent value. He was a man of very extended knowledge and wide information, but his principal interests were centred in archæology and bibliography. He devoted himself especially to the history of London, and his first important publication was his "Round about Piccadilly and Pall Mall" (1876). This was one of the first—if not perhaps quite the first—of the numerous books dealing with the history and associations of various districts of London. Later on, in 1891, he produced his "London, Past and Present," which, though nominally a new edition of Cunningham's handbook of London, was really a new book. It certainly is, and is likely long to remain, one of the most useful and complete handbooks to the history of the great city. The book, however, which established his reputation as a writer was certainly the admirable annotated edition of "Pepys's Diary," which was published during the years 1894 to 1899, and this is without question now recognised as the standard and best edition of the Diary. It was the publication of this book which led the University of Durham to pay him the compliment of making him an Honorary D.C.L. of that University, and this compliment he always valued very highly.

The three books above mentioned were certainly his most important contributions to literature, but a complete list of all the books he wrote and edited would really be too long for insertion. Mention may be made of his edition (1884) of Wraxall's well-known Memoirs, and his "Samuel Pepys and the World he lived in" (1880). He edited several English texts, and also wrote on book-bindings, cataloguing, indexing, and other bibliographical and antiquarian subjects. He read numerous papers before the Philological, New Shakespeare, and Folk-lore Societies, as well as before the Society of Arts. He also gave one of the Friday evening discourses before the Royal Institution. He was actively associated with the foundation of various societies. He was one of those who, under the leadership of Dr. Furnivall, founded the Early English Text Society in 1864, and from its foundation till 1872 he acted as its Honorary Secretary. He was the founder of the

Index Society and of the Samuel Pepys Club, a dining club established in commemoration of the diarist; and he took part in the foundation of the London Topographical Society and the Library Association. It will therefore be seen that his life was full of many and varied interests. He was a patient and laborious worker, of indefatigable industry. He was the owner of a small but select and valuable collection of bookbindings, and had also collected a useful and complete, though not very large library.

Of his work in connection with this Society, it is enough to say that his earnest and patient devotion to his duties earned the full approbation and satisfaction of the Council and the numerous members of the Society with whom he was associated; while the present writer, whom he assisted in the executive management of the Society for some thirty years, can but testify to the value of his services and the whole-hearted loyalty with which those services were rendered. On his retirement he was granted a moderate pension, and the members of the Council subscribed to present him with a personal testimonial besides electing him a life member of the Society. A man of simple and kindly character, he attracted alike the respect and the affection of a very large circle of friends, who appreciated, not only the value of his untiring labours, but the personal qualities which endeared him to all who knew him.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 9.—Professor William Ripper, D.Eng., D.Sc., Vice-Chancellor of the University of Sheffield, "Works Organisation and Efficiency." Dugald Clerk, D.Sc., F.R.S., Chairman of the Council, will preside.

May 16.—Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment."

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

May 17.—A. C. Chatterjee, I.C.S. (United Provinces), "The Development of Banking and Thrift in India." The Right Hon. Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G., late Governor of Bengal, will preside.

Colonial Section.

Tuesday afternoon, at 4.30 p.m.:—

May 8.—Captain Philippe Millet, Colonial Editor of *Le Temps*, "The Problems of French North Africa." The Right Hon. Lord Blyth, Chairman of the Colonial Section Committee, will preside.

Howard Lecture.

Monday afternoon, at 4 p.m.:—

William George Fearnsides, M.A., F.G.S., Sorby Professor of Geology, University of Sheffield, "The National Shortage of Iron Ore Supplies." Lecture II. Overseas Iron Fields which Supply the British Market.

May 7.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 7...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Howard Lecture.) Professor W. G. Fearnsides, "The National Shortage of Iron Ore Supplies." (Lecture II.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. A. R. Whately, "The Prerequisite of a Christian Philosophy."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Geological Society, Burlington House, Piccadilly, W., 5.30 p.m. Lord Headley, "The Goods Clearing House System Explained."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Miss M. Newbigin, "Race and Nationality."

Tuesday, May 8...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Captain Philippe Millet, "The Problems of French North Africa."

Chadwick Public Lectures, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Professor A. Henry, "Forests, Woods, and Trees in relation to Hygiene." (Lecture I.)

Royal Institution, Albemarle-street, W., 3 p.m. Professor C. S. Sherrington, "Rhythmic Action in Muscle and Nerve." (Lecture II.)

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. R. E. Crowther, "A Demonstration of an Improved Method of Silvering Glass."

Colonial Institute, Caxton Hall, Westminster, S.W., 8.30 p.m. Mr. R. Williams, "The Milestones of African Civilisation."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 5 p.m. Mr. C. H. Cooper, "Collection and Disposal of House Refuse."

Wednesday, May 9...Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Professor W. Ripper, "Works Organisation and Efficiency."

Automobile Engineers, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. A. W. Reeves, "Works Organisation."

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. W. L. Nash, "Animal Worship in Egypt."

Thursday, May 10...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor G. Murray, "Pagan Religion at the Time of the Coming of Christianity." (Lecture II.)

Optical Society, at the Chemical Society, Burlington House, W., 8 p.m.

Friday, May 11...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor J. Joly, "Radio-active Haloes."

Astronomical Society, Burlington House, W., 5 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Saturday, May 12...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thompson, "The Electrical Properties of Gases." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, MAY 16th, at 4.30 p.m. (Ordinary Meeting.) SIR C. ARTHUR PEARSON, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, Address on "The Blind Sufferers from the War, and their future Employment." The RIGHT HON. WILLIAM HAYES FISHER, M.P., Parliamentary Secretary, Local Government Board, will preside.

THURSDAY, MAY 17th, at 4.30 p.m. (Indian Section.) A. C. CHATTERJEE, I.C.S. (United Provinces), "The Development of Banking and Thrift in India." THE RIGHT HON. LORD CARMICHAEL, G.C.S.I., G.C.I.E., K.C.M.G., late Governor of Bengal, will preside.

HOWARD LECTURE.

On Monday afternoon, May 7th, PROFESSOR WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., delivered the second and final lecture of his course on "The National Shortage of Iron Ore Supplies."

On the motion of the CHAIRMAN a vote of thanks was accorded to Professor Fearnsides for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, May 8th, 4.30 p.m.; THE RIGHT HON. LORD BLYTH, Chairman of the Colonial Section, in the chair. A paper on "The Problems of French North Africa" was read by CAPTAIN PHILIPPE MILLET, Colonial Editor of *Le Temps*.

The paper and discussion will be published in a subsequent number of the *Journal.*

EXAMINATIONS.

The total number of entries received for the May division of the Society's examinations, which commence on Monday next, is 15,774, making, with the numbers entered for the March division (10,411), a total of 26,185. This includes applications from 279 prisoners of war or interned men at Ruhleben, Groningen, Chateau d'Oex, and Mürren, at all which places special arrangements for examinations have been made.

The total number of entries for the examinations in 1916 was 25,991, of whom 87 were interned men or prisoners of war examined at Ruhleben and Groningen. It will thus be seen that there is a slight increase in the total number of entries for the current year, though the numbers are still very far behind the entries for 1914 (37,974). This was the highest number ever reached. It should be noted that the number of original entries is always in excess of the numbers coming up for examination. The difference varies; it has of late years been about 8 per cent.

There was a heavy reduction in 1915 due to the war, and the diminution continued last year, so it is extremely satisfactory to know that the falling-off has now come to an end. It is also satisfactory that this slight increase has accrued in spite of the additional amounts which were added to the entrance fees last year. The financial result is also good, as the total received in fees for the present year is £3,430, an excess of £700 over the corresponding figures for 1916. It is not yet possible to say what the financial result of this year's examinations will be, but it may be expected that the adverse balance, if any, will be very small as compared with that shown in the last two financial statements of the Society, which showed losses on the examinations of £875 in 1914-15, and £1,035 in 1915-16.

The proportion of candidates entering for the principal commercial subjects seems much the same as usual; but it seems hardly worth while to give any figures, as full details will be provided in the annual report on the examinations. It may, however, be interesting to refer to some of the language examinations. French is the only modern language for which the entries

are really high. This year there are altogether 2,156 entries, and this shows a falling-off on last year, when 2,285 candidates actually came up for examination. Examinations in Russian have been held for many years, but only with an insignificant number of candidates until last year, when there were 127. In the present year the numbers have more than doubled, as they have now reached 314. This is the largest number of entries for any modern language subject, except French. German, for which a considerable number (about 500) used to enter, dropped to 270 last year, and the entries this year are only 256. Spanish has increased from 149 to 270, and Italian from 61 to 83. As regards the examination in English for foreigners, which last year attracted 547 candidates, only 248 entries have been received. No examinations were held in Danish and Norwegian, Swedish, Dutch, Hindustani, Chinese, Arabic, or Japanese, there being few or no entries for these subjects. The numbers also entering for Portuguese were very small, and therefore no examination was held in this subject. This is the first year in which it has been dropped.

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

WEDNESDAY, MAY 9th, 1917; DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

O'Brien, Major Aubrey John, C.I.E., Hillside, Merstham, Surrey.

Thomas, Wyndham, Elsham Hall, Elsham, Lincs.

Wilson, J. Howard, A.M., Ph.D., Castine, Maine, U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society:—

Aundh, The Chief of (Balasahib Pant Pratinidi), Aundh, District Satara, India.

Bleloch, William Edwin, Hazleyshaw, Albemarle-street, Kensington, Johannesburg, Transvaal, South Africa.

Bux, Hafiz Mahomed, Islamya Hotel, Ajmer, Rajputana, India.

Conlay, W. L., Kuala Lumpur Selangor, Federated Malay States (*viâ* Penang).

Gibson, William James, Box 470, Smit-street, Hospital Hill, Johannesburg, Transvaal, South Africa.

Jennings, Hon. James George, M.A., Ranchi, Bihar and Orissa, India.

Mardon, Ernest George, Avonbank, Clifton Down, Bristol.

Sutherland, Alexander, care of C. P. Edwards, General Superintendent, Radio Branch Naval Service, Ottawa, Ontario, Canada.

The paper read was—

WORKS ORGANISATION AND EFFICIENCY.

By PROFESSOR W. RIPPER, D.Eng., D.Sc.,
Vice-Chancellor of the University of Sheffield.

THE PROBLEM.

At a recent joint meeting of employers and trades union representatives, at which the writer was present, to consider ways and means of ensuring industrial peace after the war, a workers' representative said: "You employers are rich and comfortable, and the workers are, or were before the war, in want of all those things which go to make life really worth living. We demand that the present war-time wages shall continue after the war, and I want to ask you employers: Are you going to agree to a reduction of your profits; are you going to be willing to sacrifice some of your large incomes in order that the workmen may retain a decent living wage and continue the better home conditions which they have been recently enjoying? I cannot see," he said, "how the men can continue to receive higher wages without injuring their employers, nor how it is possible therefore to avoid industrial trouble when the war is over."

The purpose of this paper is to endeavour to show how it is possible to maintain a higher rate of wages than prevailed before the war, and to do so without injuring the employer and without the necessity of industrial strife between employer and employed.

THE WAY OUT.

To accomplish this desirable result there is only one method, and that is to increase the national output of wealth-producing goods and services, so that there may be more wealth to distribute than was the case before the war. It is certain that if production is not increased, then all the demanding in the world will not result in an increase of wages or enable us to get something out of nothing.

But if production is to be increased the following things at least will be necessary:—

1. The continuance after the war of improved relations between employers and their workmen

2. The introduction of improved organisation and methods in our factories and workshops.

These are the primary necessities, so far as works organisation is concerned. There are, of course, many other supplementary agencies necessary to our complete success in this direction — as, for example, the national organisation of our industries, each industry being represented by its own organisation and association, and the whole centring round a Government Department of Industry and Commerce, a closer association of commercial banks with industrial enterprise, and a more efficient consular system; but these things are subjects for separate treatment, and the writer will confine himself here to the problem from the manufacturing standpoint, as representing a primary and fundamental source of our material well-being.

Improved Relations between Employers and Employed.

Already great changes in this direction have taken place as a direct result of the war and of the urgent need of the Navy and Army for war material. There has been an enormous improvement in our methods of working, as well as in the spirit of willingness to work together and to co-operate and associate, the effect of which has been to secure a rate of output exceeding anything ever before obtained in this or any other country.

This accelerated output has been due, in the first place, to the united efforts of all concerned actuated by the one great purpose of winning the war. There is, however, as we all realise, the danger that after the war this spirit of co-operation will not continue, and that the subjects of dispute between Capital and Labour, when the present single aim has been removed, will be so many and so numerous as to make serious disputes more or less inevitable. If the causes of the old troubles remain, it is as certain as that night follows day that the results will also remain. The causes in the past which have led to these troubles have been too often similar in kind to those which are responsible for the great world-war. Prussian Militarism is concerned only with conquest, and disregards absolutely the human price that is paid to accomplish its purpose. So in the past our commerce, trade and manufacture have been conducted too much for the one object of profit only and without any regard whatever to human and neighbourly considerations. But both these conditions contain within themselves the seeds of their own destruction. The one is in process of being destroyed at the present moment on the fields of France; the other as the result of a broader and wider outlook is recognising the claims of a larger responsibility. There are reasons for believing that wiser counsels may henceforth be expected to prevail. The lesson of the need of mutual co-operation has been burnt into our consciousness during this war as never before, and it seems certain that employers and their workmen who have fought together as officers and men at the Front will return to their work, not to fight each other in industrial disputes, but to co-operate to bring about a solution of the difficulties which lie ahead by joint and friendly discussion.

The spirit of co-operation is not a mere sentiment or theory. It has been as much a scientific necessity for the winning of this war as the provision of guns and ammunition, and it will be equally a scientific necessity to success in the arts of peace. Co-operation will be secured as the result of confidence—confidence on the part of the employers that the men will do their best for the firm, recognising that their interests and the interest of the firm are identical; confidence on the part of the men that the employers will do their best for the men as opportunity arises, and that the general well-being of the work-people is recognised as an essential factor in the success and well-being of the firm. Mutual concessions will, of course, be necessary, and a great responsibility will rest upon every man, whether employer or employed, to do his best in this direction.

It is encouraging to note the increasing recognition of the value of mutual discussion between the representatives of masters and men, not merely for the purpose of settling disputes, but for purposes of mutual helpfulness to clear up a difficult situation. Recent experiences in this direction have discovered the presence on both sides of unexpected goodwill and sympathy with the other's point of view. So long as this spirit prevails it will be found that there are no difficulties in connection with which it will not be possible to find some reasonable solution.

It is better understood now than ever before that the interests of an employer and his work-people have more in common than was formerly supposed. It is increasingly recognised by the employer that it is to his interest that his work-people shall be well fed, well clothed, well housed, well educated, and that they shall enjoy a decent and comfortable standard of living. On the other hand, it is increasingly

recognised by the worker that it is to his interest that his employer shall be successful if he is to maintain his business in a high state of efficiency and improve and develop it to the utmost. There can, of course, be no continued employment with a firm which is financially unsuccessful and unsound, and therefore incapable of keeping its doors open.

Works Organisation and Efficiency.

But the spirit of willingness on the part of the worker to work together with his employer for the common good, great and important as it is, is not sufficient without the provision on the part of the employer of the organisation and equipment which is necessary to efficiency of manufacture. In this respect employers are faced with a great responsibility.

It is true that in this country we have manufacturing concerns whose organisation and equipment are second to none in the world; but, on the other hand, it is true also to say that, generally speaking, our works are on a small scale as compared with those of our competitors, and, so far as equipment and organisation are concerned, they are, in too many cases, twenty or thirty years behind the times. While, on the one hand, the American and German manufacturers have been developing works organisation on a huge scale, our own manufacturers have been content to jog along in the old way.

Increased output after the war does not mean that our workers are to be called upon to work harder physically than they did before the war, though there will be less room for slackers of every description in all departments of our national life, but it does mean that though there may not be a demand for more muscle there will certainly be a demand for more brains, that inefficient methods and appliances must give place to better and more efficient methods, and, above all, that we must begin to organise our industries on a scale commensurate with the task which lies before us of competing successfully in the world's markets against highly organised competitors equipped with every means for large-scale production and with every agency for securing contracts and for the efficient sale and distribution of their goods.

Association of Small Firms.

The question of organisation involves the need of a greatly extended tendency towards external association of small firms into larger combinations as well as internal organisation and improved equipment and method.

There has been much that is admirable in the British tendency to individuality and independence, but it has been a costly luxury in trade, and one which will have to give place in the future to a more general tendency to association and combination. It is owing to the fact that businesses in this country are conducted on so small a scale that our costs per unit of output are so excessive, and that our manufacturers are handicapped by not being able to compete in price against the larger organisations abroad. The weakness of a small firm attempting to perform the whole of the processes connected with a given trade in their own little works is that their standing charges are excessively high considering the relatively small amount of their total output. Their plant is, in fact, out of proportion to their turnover. The methods of the small employer are not properly manufacturing methods, they are the methods of the manual worker, and as such, in some special industries where skilled craftsmanship is indispensable, they will still remain as a permanent factor of high-grade industry; but for trades in general that can be more profitably carried on on a large scale by means of repetition machine work, they will of necessity be superseded by the component specialist whose output is large and whose standing charges are relatively small.

Specialisation.

Modern manufacture differs very considerably in its methods from those of times gone by. At one time an engineering establishment with a by no means large equipment would undertake to make anything from a stove-grate to a power plant. But with the growth of competition it has now been found wiser to concentrate one's energies within a more restricted field—in other words, to specialise. Many firms have proceeded so far on these lines as to make not only one type of machine, as, for example, pumps or drilling machines, but to confine themselves to a certain limited number of standard sizes in their specialty. A well-known firm of machine toolmakers recently informed the writer that in years gone by, when they undertook to make machine tools to meet the whims of every buyer, their business was a constant source of anxiety, and they made very little out of it. but since they began to specialise and to build only certain well-defined types, and in a limited number of sizes in those types, their business has gone ahead by leaps and bounds; their

costs of production are much reduced; their processes are standardised; their men are paid better wages, and they are now continually extending their business. It is, in fact, by means of manufacture by quantity and by special machinery that costs are reduced and business increased. In many branches of manufacture firms confine themselves to supplying certain component parts only, such firms being directly or indirectly associated with other firms who take other stages in the process of manufacture from the raw material upwards.

To carry on business in any industry along the line above indicated — namely, that of specialisation of product—there is need of a very much more whole-hearted attempt at association under some central or agreed control than has hitherto taken place, with a view to the sub-division of processes and the provision of suitable machinery to manufacture by repetition methods a limited number of processes by any one firm.

Fortunately, great changes are taking place at the present moment in this direction. Firms in all sorts of industries all over the country are combining together for the purchase of their raw material, the sub-division of the processes involved in their particular department of trade, and the selling of their products in the home and foreign markets through a single organisation instead of by a multiplicity of small isolated and costly efforts of their own. They prefer to unite their efforts so as to be able to compete successfully with their foreign rivals rather than spend their substance in fighting each other at home. A recent notable example in this direction is that of the Machine Toolmakers' Association, who have agreed together that individual firms will cease making a large variety of tools, but that the work shall be divided, so that each firm will become a specialist in a certain type of machine.

The North-East Coast Marine Engineers, who are standardising their designs and sub-dividing their processes, are another notable example in the same direction.

Internal Organisation of Works.

In the matter of internal equipment and organisation, old-established firms in this country labour under a great disadvantage as compared with their competitors in other countries who have been able to begin with new and up-to-date buildings, plant, machine tools and lay-out, and to profit by the lessons of experience paid for, often very dearly, by their predecessors. To transform an old-established works into a plant laid out and equipped on modern lines is by no means an easy task. It involves, in the first place, considerable initial outlay, but it is undoubtedly worth doing.

An American was recently walking through the workshops of a very old-established and well-known industry, and was asked what he thought of them. His remark was "that they required a match," and this really truly describes the situation in many cases. Where possible, it pays to provide suitable and well-laid-out buildings, well lighted, well warmed, and well ventilated, and to provide those buildings with the most up-to-date and efficient machine tools, conveniently arranged for large-scale production, and properly balanced as to types so that there is no congestion of the work at any one point, and supplied with all necessary facilities for transportation from stage to stage, including delivery of the material and unfinished parts always at the right place and at the right time.

To provide such equipment is to come into line with modern practice; to omit to do so is to labour under a severe handicap in competition with those who are equipped to the utmost limit of efficiency both of appliance and method.

Elimination of Waste.

The leading principle dominating modern methods throughout is the elimination of waste —waste of time, waste of material, waste of effort, waste of health. In times gone by the amount of waste in all directions has been appalling, and when it is considered that every form of waste increases the cost of manufacture of the unit of product, the reason is obvious why the scale of wages has been low. To increase the scale of wages paid, drastic steps must be taken to reduce waste in all directions, and if a really earnest endeavour is made by both employers and workmen, each in their own way, in this direction, it will be quite possible to increase so greatly the wealth-producing power of all the trades in this country as to secure after the war an increased output of work sufficient to produce the increased rate of wages desired.

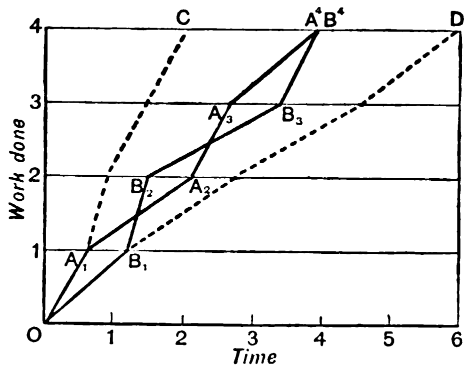
The authors of "Eclipse and Empire" state it as their opinion "that it is safe to say that, by means of the saving of waste and the invention of new methods and materials, the whole of the expenses of this great war could be defrayed in one generation."

The prevention of waste is essentially a scientific problem, and it must be attacked by the scientific method. This method has been applied by engineers with immense success in the study of power plants with a view to discovering and removing sources of loss, and thereby increasing efficiency. As a result of this careful method of study, the cost of the unit of power to-day is anything from one-quarter to one-tenth of what it was fifty years ago, and this extraordinary result has been due to the policy of devoting continuous attention to the effects upon economy of a succession of small improvements.

But this is only the beginning of the problem for the engineer, and far greater problems await him in connection with the study of manufacturing processes. Hitherto very little systematic research has been made in this direction.

Standardisation of Shop Method.

How great the need is for improvement may be illustrated by the use of the diagram. The principles of this diagram are that there are many ways of doing the same thing, but there is only one best way. The discovery of the best method and the recording of the same is what is known as "standardisation of method." It includes the discovery of the best methods for every successive and separate process in the complete operation—in other words, the most expeditious way of getting the work through from start to finish, and involves the planning of the work, the arrangement of the sequence of operations, the supply of properly prepared tools, the selection of the most suitable material, and the prevention of waste of time due to waiting for jobs.



The diagram supposes a piece of work to require four operations from the raw material to the completion of the finished product. Two pieces of work, "A" and "B," were started at the same time, but by different methods. In each of the respective stages, the irregular A line indicates the rate at which the work is done upon the article "A," and the irregular B line similarly indicates the rate at which the work is done upon the article "B." It will be seen that during the first operation the A process is quicker than the B process; in the second operation it is slower; in the third operation the A process is again the faster, and in the fourth operation it is the slower. The total time required to complete both articles "A" and "B" is shown by the diagram to be the same.

This diagram well illustrates the conditions obtaining in all forms of manufacture. It is obvious by studying it that each of the articles could easily have been completed in considerably less time. For example, in the first operation there is no reason why the "B" process might not, in the future, be similar to that employed in "A," and if, in each operation respectively, the best methods be adopted, the operation will be completed in the time given by the line *OAC*, obtained by extending the line *OA* parallel to that of the best process in each case, the whole line representing the sum of the best processes. This line, therefore, represents the standard method of doing the piece of work in question until some still better method is discovered. If the four separate operations had not been analysed it would never have been discovered that any such improvement could have been made, and therefore, if no attention had been given to the time involved in the manufacture of the article, there is reason to fear that the quicker process in each case might easily have degenerated into the slower methods in each case. By summing up all the slower methods we get the line *OBD* drawn parallel to the slower processes, and showing that the total time taken in this case is several times as great as is required by the standard method line *OAC*. In many branches of manufacture, instead of there being only four operations, as shown on the diagram, there might easily be forty, in which case the difference between the summation of the forty best methods and the forty slower methods might make a very considerable difference indeed in the final cost of the product, resulting in the one case in a handsome profit and in the other case in a serious loss.

The principles of this diagram are of general application, and may be used to locate sources of loss throughout the whole process from

the raw material upwards. Careful study of operations on these lines determines that the most suitable raw material is employed; that the most suitable machines are selected for the work to be done—heavy work for heavy machines, and not small jobs put in a machine two or three times too big for the purpose; that the men are carefully selected so that each does that portion of the work which is most suitable to his particular grade of skill. Costs are also kept down by keeping machines constantly running instead of standing a large part of their time idle, one man to one job, and not frequent changes of work in the same machine or for the same man, the effect of which would be to waste the time both of the machine and of the worker. Care is taken also to secure the best attention to speeds, feeds, and cuts; the preparation of special tools and the best forms of jigs and fixtures to secure indefinite repetition of processes with perfect accuracy and interchangeability; the planning of work beforehand so that there is no waiting either by men or machines, and as little time as possible lost between operations; facilities for handling work, placing it in the machine, taking it out and securing its efficient routing through the factory; arranging for economy of distance travelled by the piece of work between operations; the checking and inspection of the raw material and of the finished product; the efficient maintaining of the tool room so that tools are always ready when needed and delivered beforehand.

These conditions represent, no doubt, a counsel of perfection, and can only be carried out perfectly in branches of manufacture where the product is more or less of a standard pattern. As a works finds itself engaged in more and more complexity of types the operation of economising becomes more and more difficult to realise, and this difficulty of avoiding waste as complexity of manufacture increases is one of the strong reasons for the simplification of manufacture and the tendency towards specialisation and standardisation of product.

Sub-letting of Authority.

Improvement in shop method has hitherto been dependent upon the efficiency of the shop foreman; but there is no official in any works establishment who has more calls upon his time and attention, or a greater variety of duties to perform. What is needed in our workshops is a sub-letting of certain of the foreman's present duties among at least two well-trained young men acting as assistants to the foreman, to take over certain sections of his duties, and to be solely responsible for the handling of one or more of the elements above described as constituting efficiency of method.

There has, of course, in the past been a certain amount of resentment shown by the workman towards suggestions for improved methods; but we hope and believe that that time has now gone by. No class of workers will really be content to continue along their old methods when newer and better methods are known to be in force elsewhere and to be employed by their rivals, especially when the introduction of the improved method is at the same time accompanied by increased pay for the worker without demanding of him any increased tax upon his physical strength or power of endurance. The old slow method really involved more physical strain than the newer machine method, and the workman of the old days of the hammer and chisel and file lived a far more strenuous life than the machinist of to-day, who can do ten times the amount of work with the exercise of far less physical effort.

Costs.

The importance of a good system of costing as a means of efficient control of a business, and of discovering weak places in it, is more and more fully realised by manufacturers; such a system is in fact in these days indispensable. It must present comparative results showing the progress separately of the various departments, in order to discover the relative merits of their respective methods, and to discover also the effects of changes of methods.

A costing system begins where accounting leaves off; it proceeds backwards and inwards from the totals to the analysis of the contents of the various items of expenditure, and especially notes relative costs and comparative results over given periods. There are firms that produce from fifty to one hundred or more different types and kinds of goods as constant lines of manufacture, but who frequently do not know the actual cost of any one type, which of them is paying its own way, and which of them is being carried as a burden on the business.

A good costing system intelligently handled points out the direction in which improvement is possible and necessary, and is a splendid instrument of efficiency.

Education.

It will be obvious from what has been already said that the future of our industries,

their efficiency and their power to maintain their position in competition with all the nations in the world market, will depend upon the quality of our industrial army and their ability to meet the increasing claims which will be made upon them.

Above all, there is a great demand for skilled and competent leadership and for organising and administrative ability, and business and commerce will be keen rivals with the professions for the best talent that the country can produce. The demand of every branch of industry for men of scientific training and experience will be greater in the immediate future than ever before, in order to bring the results of advanced practical science into the works and to apply such science to the immediate needs of industry; to introduce new and improved methods of investigation and measurement, and, on the chemical side, to devote themselves to the study of the utilisation of waste products and the improvement of wasteful methods.

The necessity for a supply of young men with commercial training and with a competent knowledge of modern languages, including Oriental languages, to represent our commerce in foreign markets is now more fully realised, and it is to be hoped that a more serious effort will be made in the future than has been the case in the past to provide such a training.

Finally, the provision of trade training for apprentices, and of a continued education through part time for all boys up to the age of seventeen or eighteen, is now admitted to be a necessity, not only for our industrial, but for our national well-being.

We realise the need of an improved education for the worker in order to broaden his mind, so that his daily work may not be his only interest, and so that his daily life may become something more than a merely sordid drudgery for wages. We desire for him that he shall feel some pride in his work and understand something of its relation to the whole scheme of national industry; that he shall be possessed of health in body and mind; that he shall become not only useful in industry, but intelligent and active in the world of affairs, and that his capacity for interest in life shall be enriched by all that comes from a broader outlook than merely that of his own immediate industrial surroundings.

The future of our industry must be something more than a mere fevered scramble for profit on the part of the employers or for wages on the part of the men. Trade and industry must be recognised as the natural healthful and normal means whereby the nation is able to express itself in useful service, and to realise itself in ever-improving quality of work, as distinguished from the increase of mere quantity. To accomplish this result will require from each of us, from the highest to the lowest, some helpful effort of our own and some devoted and loyal service in promoting the well-being of the industry to which it is our privilege to belong.

DISCUSSION.

The Chairman (Dr. Dugald Clerk), in opening the discussion, said he was sure the members thoroughly sympathised with the author's wish to improve the lot of the working-man. In the Opening Address he (the Chairman) gave to the Society at the commencement of the session he said very much the same thing, and dealt with the point that the workman's wage could only be increased by increasing the production. In the report of the Census of Production for 1907 several important points were dealt with which should be known both by the workmen and the masters, the first being the extremely small amount of net production in this country. The net production was determined by taking the value of the things which went into the works, and the difference between that and the total output represented the net production of the works, *i.e.* that was the amount by which the value of the materials in existence in the country was increased in that particular works in a year. If that total net production, which was unexpectedly low for Great Britain, was divided between the whole of the work-hands in Great Britain it gave an average for all industries of £102 per head per annum. That meant that if every work-person in Great Britain were paid £2 a week there would be no profit for capital and no fund for building new works. On the other hand, the American Census of Production for 1909, the last date available, comprising the previous five years' figures, showed that the average, tested in the same way, was £147 per head per annum, and the actual payment made to the American workman was roughly £100 per annum; so that the American workman received as much for his work as would swallow up the whole amount for Great Britain altogether. One of the most beneficial agents in this country had been the establishment of trade unions, which had done most useful work on the whole for the benefit of the country, although employers might occasionally be annoyed by their actions. Anything which raised the standard of life of the working-man increased the prosperity of the country. He was all for increasing the wage of the working-man, but he desired to point out that he

could not obtain the sufficient wage he wanted out of the present output. The output must be increased. The reason it was not increased was that the workman had a fear that if he was on piece-work, and he made too great a turnover, the master would attempt to reduce the piece-work rate, and too often, he was sorry to say, the master had made that attempt. As a result, the workman had a certain reluctance in increasing his rate of work. If he thought he had a sufficient wage he did not wish the piece-work rate to be lowered. On the other hand, the master had before him the fear of the Bankruptcy Court. His business in the first instance was to keep out of the Bankruptcy Court, and that was not so easy as the workman thought. The workman spoke of the large profits of the masters, but they were not large compared with the total capital involved. The master found that if there was not too great an output in the particular article he made the price remained high, and his margin of profit was greater, and as a result even among the masters there was a strong tendency not to increase the output indefinitely. The workman did not wish to increase the output because he did not wish his rate of wage to go down, and the master very often did not wish to increase the output because he was afraid of producing a glut in the market. The English trade unions, partly from a feeling that there were only a certain number of jobs to go round, and that if each workman did more some other workman would run short of employment, rather favoured the restriction of output. On the other hand, in America the trade unions did not do so. They pressed for the highest payment for the highest output; and if the English trade unions could be induced to take the view that their class would be well served by the highest output and the highest rate of payment it would be very much better for the country. Another point was that if the country required a certain total of goods and the rate of output per workman was increased, naturally if the total remained the same the work could be done with less men. One thing that everybody forgot was that the people of the country themselves were the ultimate market. There must be a greater study of the balance of necessary things, and when labour was apportioned, as the author had suggested, it would be possible to increase the output indefinitely. For instance, it was quite obvious that everybody could not eat iron and steel; therefore they could not all be engineers, because if the whole of the country consisted of engineers it would depend absolutely on an outside country for its food. If the world tended to a disproportion of industry the world would suffer, and poverty would be the fate of somebody, because labour had been applied where it should not have been used. He thought it would be found that the employers at the present time were really desirous, in very many cases, of finding a way out of the difficulty, so that both the employer and the employed might live together in harmony, and work together for the common end of supporting the whole of the country in a state of prosperity.

Sir Robert A. Hadfield, F.R.S., after calling attention to the fact that the present was the author's first public appearance since his appointment as Vice-Chancellor of the University of Sheffield, on which he was sure all the audience sincerely congratulated him, mentioned that the Sheffield University had also recently established a Faculty of Metallurgy. In the past the metallurgist had been tied rather too much to the engineer, but the development of metallurgy had been so enormous during the last generation that it deserved a Faculty, and the metallurgist could now go to his own Faculty and work out his own problems. The author had referred to the question of improved relations between employers and employed. It was no good minimising the fact that at the present moment there was unfortunately a spirit of great unrest in this country. It was necessary for everybody seriously to study the question, and now that attention had been turned to it he thought a solution would be found. The study of the differences between capital and labour was just as important as the study of engineering, metallurgy and economics, and by a combined study of the question by all those concerned in the development of the progress of the world, such as engineers, lawyers and doctors, a very much happier solution would be arrived at. He was glad to say that a new association, called the National Alliance of Employers and Employed, had been formed as a result of the work of the new Federation of British Industries. He hoped that in the near future an organisation would exist in which employers and employed would sit together at the same round table, and not, as had too frequently happened in the past, in different rooms. The Alliance embraced a number of important employers representing large industries in the country, and also a large number representing the employees, and he hoped before long it would give a good account of itself and discuss questions, not when a strike was about to take place, but long before that time, an endeavour being made to ascertain what it was that led to strikes. He specially referred to the matter because there was very serious labour unrest in the country at the present time. He very earnestly appealed to the workers of the country to remember the present situation, because he did not think some of the workers realised that the country was fighting a very serious battle for its freedom. The least he could say was that to stop output at the present time was very unpatriotic. He urged upon the workers that the present was not the time to bring up the points they desired to raise for discussion. If they had any real grievance the Minister of Munitions and the head of the Labour Department, Mr. John Hodge, were quite willing to take into full consideration any just and reasonable demands. The author had referred to

some of the works in this country as very old-fashioned, but he was proud to say, speaking for his own firm, that he could take any American, German or Frenchman round his works in the full belief that they could not do any better, if as well. Many English works were old because they had been in existence a long time and had not kept up to date, but it was not the easiest thing in the world to wipe out all the capital of a company in a year or two, although he agreed that more of the profits should be put on one side for improvements and developments. He was a Free Trader of long standing, and believed in a fair field and no favour, but the manufacturers of this country had not had a fair field. His attention was called in 1911 to a very serious disability under which the iron and steel maker in this country was labouring, which no amount of better plant or new works could overcome—namely, that the Germans were sending iron and steel into this country under a bounty. In other words, if iron or steel cost £6 a ton the Germans were exporting to England at £5 10s., and a difference of 10s. a ton was quite sufficient to wipe out all competition. He believed a good deal of the success of his own firm had been due to the very accurate system of costing that had been in existence for the last twenty-five years. It was necessary to analyse costs almost as carefully as a specimen of steel to determine its various elements, and a specialist was required for that purpose. When going round the works in America he found specialists had been appointed to teach the smaller firms that part of the business. There was no doubt that a small firm could not live nowadays unless it knew to a halfpenny the cost of the article it produced. It might find out that it could make one article more cheaply than another, and if it was wise it would try and make that article only. In the future the smaller firms would not do the business they had done in the past fifteen or twenty years unless they paid attention to that subject. Throughout his life he had always said that, if properly handled, there was not a better workman in the world than the British workman, and that view had been confirmed by many eminent heads of works, British and foreign, who had visited Sheffield. If employers pinched the workers in their wages they deserved all they got. Two months ago the greatest scientist in the world, Edison, who was also a great practical man, pointed out in an article in the *Observer* that the one great mistake the employers in this country had made was the effort to pay too low wages. If the men were paid well, he believed the British workman would respond. The British workman should not be told that he was not up-to-date, and that he was behind the times, because it was not true and he did not like it. If old England had a fair field and no favour in the future he was sure it could hold its own against the world, but some of the changes to which he had referred must be brought about.

MR. ALEXANDER ROSS (Past President, Institution of Civil Engineers) agreed with the author and Sir Robert Hadfield that in the past the workmen of the country had not been dealt with to the best advantage; and all parties, whether politicians or practical men, were fully satisfied that something better must be done in that direction in the future. It was necessary that there should be a general levelling-up of the wages of the workmen in order to make them more comfortable. He endorsed the remarks that had been made in regard to the necessity of systematic costing and systematic book-keeping, in order that the managers might know the exact costs of work. By means of co-operation and additional education, whereby first-class managers, buyers and salesmen were produced, he believed success would be achieved in the future.

PROFESSOR E. G. COKER, F.R.S., said the majority of the population had come to the conclusion that a state of stress might exist in the country at the end of the war which was even greater than that which existed at the present time; but personally he did not think that would be the case, because a great transition was being passed through from the old to a new state in which everybody was arriving at a new point of view. At the beginning of the war the working-man very soon saw that it was necessary for him to throw over a great many cherished ideas about output, and the employer had to seek new methods; in fact, they all had to come to a different point of view from that which previously existed. At the end of the war he thought everybody would be found ready to make a fresh start, and to take advantage of the experience that had been gained during the war. People concerned in engineering could roughly be divided into the employers, the employed, and those who produced inventions which were the cause of the establishment of new industries, and he was sure those three classes would in the future pull together in a way they had never done before. It was a remarkable fact that the country had always possessed most wonderful workmen, who through generations had been noted for their skill, and also wonderful leaders of industry. The country had never been lacking in men of great original genius who had led the way in modern inventions, but, unfortunately, it had not profited nearly as much as it should have done, because the three classes had never pulled well together. In the future he believed there would be the most complete accord between all classes, and that thereby very great results would be effected. He hoped the trade unions would take to heart the statement made by Sir Robert Hadfield that there was no limitation of output in America, because it was quite obvious from the figures the Chairman had given that there was no opportunity for large wages unless there was no limitation of output. If British workmen recognised that increased production

was necessary, and that they would correspondingly be well paid for it, he did not believe there would be any real difficulty. One new aspect of the training of students, who would ultimately occupy responsible positions, which had come about owing to the war, was the training in modern languages. Scientific bodies like the Institution of Civil Engineers had already recognised that the training in engineering in the colleges was not quite broad enough, and they proposed to introduce a scheme whereby the engineering student must, before he entered the Institution, produce evidence to show that he had a real acquaintance with one modern language. That, he thought, would have a most wholesome effect on all the colleges in this country devoted to engineering training, because it would make compulsory what was previously permissive, to the great benefit and lasting good of the student and of the engineering profession.

SIR LINCOLN TANGYE, Bt., said he was much struck by the unanimity there appeared to be on the subject of the necessity of drawing together employers and employed. His firm had met with very great success in its efforts in that direction; and at the commencement of the war one large department sent a deputation to the management asking to be allowed to work as many hours as they possibly could. That, he thought, was evidence of the growth of a very fine spirit on the part of the workmen. Naturally there were exceptions to that state of things, previous disagreements in other parts of England having caused complications and disappointments, but on the whole he thought manufacturers could most cordially congratulate themselves and the country on the relations that had existed between labour and capital during the present very trying time. He trusted that at the end of the war the author's prognostication would be proved to be correct, and he had every hope it would be, owing to the feeling which had developed between employers and employed during the present critical times.

PROFESSOR HENRY J. SPOONER thought there was little doubt that while, on the one hand, it was necessary there should be increased production, there was room for a reduction of costs in the working arrangements of the firms of the country. One kind of leakage which had received very little attention, but to which much study had been given on the other side of the Atlantic, was the effect of the mobility of labour, which the Americans called the turnover of labour. In most districts there was a constant flow of workers from one shop to another, leading to low production, breakdowns and delays. No one seemed to know exactly what that cost economically, but it had been estimated by Mr. Boyd Fisher that in a worker of the semi-skilled type it cost something like £15. To remedy that state of things Mr. Fisher suggested the establishment of an Employment Department in every works of considerable size, which would to some extent correspond to the Welfare Department which some of the great works in this country had so wisely established. Mr. Fisher also believed that not a little of the turnover, which was so disastrous to the economic interests of many firms, was due to the foremen having the power of hiring and "firing" the men, and he suggested that that function properly fell to the Employment Department. Where that principle had been adopted the turnover in the first year was halved, and in the next four months was more than halved again, while the production per man was increased 30 per cent. More attention must also be paid to the human element if increased production was to be brought about, and every endeavour must be made to improve the manipulative efficiency of the workers. There was a right way of using a tool with the least fatigue to the worker, but he had never heard of anyone who had attempted to discover the right way which produced the least fatigue. If it was desired to bring up a race of workers who would be happy, contented and capable citizens, it was necessary that they should be given such a training that they would become good industrial workers. Not a little of the inefficiency of British educational methods was due to the fact that little or no heed had been paid to the psychology of attention. He hoped some space would be given in educational curricula to the study of those methods that had led to such marvellous results in the researches that had been made into the motion of the limbs, so as to reduce fatigue and humanise the worker, whereby his output was increased by 200 or 300 per cent.

PROFESSOR RIPPER, in reply, said it was necessary to recognise, as Professor Coker had said, that at the moment the country was passing through an extraordinary state of transition. It was passing from one method of thinking about things to another; and it was most remarkable that so much discussion was at present taking place on the relations between employer and employed. The subject was being discussed in a very friendly way, and both sides were anxious to arrive at some common understanding on the current difficulties with which the country was faced. It was a very striking thing also to find how much discussion was taking place on the question of works organisation, and it was perfectly certain that out of all that careful thought something good would come. The weak points in the industrial system of the country were now being appreciated, and as a result of the attention that was now being given to the subject he had no doubt that lasting benefit would accrue.

On the motion of the CHAIRMAN a hearty vote of thanks was accorded to Professor Ripper for his interesting paper, and the meeting terminated.

ENGINEERING NOTES.

The German Submarine "Deutschland."—The American journal *Motorship* gives a description of the German commercial submarine "Deutschland," built at the Krupp Germania Yard, Kiel. Her chief engineer is reported to have stated that her engines are of the four-cycle type, and that the Krupp bronze construction has been retained only in the two-cycle motors, the four-cycle being built of steel and cast-iron. The "Deutschland," he adds, has two six-cylinder four-cycle Krupp engines, developing 600 b.h.p. each at 380 revolutions. The cylinders have a bore of 15·748 in. and a 19·685-in. stroke. The engines can run at from 200 to 400 revolutions per minute. The four-cycle engine, said the chief engineer, is rapidly taking the place of the two-cycle in Germany. The latter is used where high speed and power are required in compact form under special conditions, such as naval work, but for commercial work the four-cycle motor is in the ascendancy. The *Scientific American* also deals with the same ship, and states that she is 230 ft. in length, built on the usual system, having a circular hull proper, with what may be termed an enlarged false hull outside of this. The beam of the hull proper is 17 ft., the full beam of the ship being about 30 ft. She is driven by Diesel engines developing 1,200 h.p., the engines being six-cylinder, two on each shaft. The speed on the surface is 14 knots, and under water 7·5 knots. The time taken to submerge from surface conditions is two minutes. According to her captain, the total distance run under the submerged condition on the last trip from Germany was 180 miles. The cargo capacity is rated at 1,000 tons. The entire crew, with the officers, consists of twenty-nine men. The "Deutschland," like all the later German submarines, is always ready for submergence; the removal of the repeater compass on the conning-tower and the closing of the conning-tower hatch is all that is necessary. The German conning-towers are large enough to hold four men. There is complete shut-off between the conning-tower and the rest of the ship when it is submerging. The speaking-tube leading from the conning-tower to the man at the wheel has also a cut-off immediately behind the helmsman; hence, should the conning-tower be shot away or punctured, two men would be lost, but the rest of the ship would be safe and could be steered from the second periscope. A small lifeboat is secured in the superstructure. The periscopes, two in number, are of great power and remarkable clarity, and are superior to American periscopes. The periscope in the conning-tower is hoisted and lowered electrically; the one in the engine-room is hoisted by a chain-drive operated by hand. The conning-tower is so arranged that air-vents open and close automatically the moment the ship emerges or submerges; by this means the ship can proceed with the conning-tower only two-thirds above water, using her Diesel engines. The deck is absolutely flush and clear of gear of any kind. The two wireless masts are about 50 ft. high, built of wrought-iron, tapering off telescopically at the top. When down, the masts are stowed in pockets on the false deck; they are raised or lowered by means of quadrants at their lower end, the quadrant being operated by motors. According to the captain, the "Deutschland" was constructed in six months' time.

Solar Ovens.—In view of the scarcity of coal or wood in many sub-tropical regions, such as Egypt, the Punjab, and the Karoo of South Africa, it is interesting to note the report recently made by Sir F. Nicholson, describing, amongst other things, valuable experiments in the employment of solar ovens. These consist of stout teakwood boxes, blackened inside and fitted with a double glass top. They are suitably insulated, and with this simple apparatus a temperature of from 240° to 275° (Fahr.) is easily obtained during the middle of the day from 11 a.m. to 3 p.m., and 290° with the aid of a single glass mirror. The oven once constructed costs nothing, and for all mere baking or cooking purposes it is a very efficient and cheap utilisation of sun heat, suitable for many applications. A summary of the report is given in the *Indian and Eastern Engineer.*

The Deflection of Continuous Beams.—A paper on this subject was recently given before the Society of Engineers by Mr. E. S. Andrews, B.Sc. He said a continuous beam is one which rests on more than two supports, and is classified as "a statically indeterminate structure, because the stresses in it cannot be obtained by an application of the laws of graphic statics only; a consideration of the deflected form of the beam is also necessary." The disadvantages which have been urged against continuous beams by practical engineers in the past will probably disappear as further experience is obtained in their design. The theorem of three moments gives a relation between the negative bending moments at three successive supports of a continuous beam, from which, in any given case, these bending moments can be obtained; by combining the free bending moment diagrams and the support diagrams the bending moment at any point can be found, and the reaction can be readily computed. In the course of his remarks Mr. Andrews gave the full calculations of the bending moments and shears for a warehouse floor framed with continuous beams. The external secondary beams carry greater loads than the internal ones on account of the continuous construction of the floor slabs, and diagrams of maximum positive and negative bending moments for loaded and unloaded

conditions are given. The maximum and minimum reactions from the secondary beams form point loads upon the main beams for the loaded and unloaded conditions respectively, the resulting bending moments, combined with those due to the weight of the beam itself, being plotted upon a diagram from which the detail design of the beam can be completed.

Energy provided from the Tides.—In his address recently to the Western Local Section of the Institution of Civil Engineers, Professor D. Robertson, D.Sc., called attention to the energy derivable from the tides in this country. He said that to raise the level of one square mile of sea by one foot involved the expenditure of about 340 kilowatt-hours. Under ideal conditions of admitting all water at high tide and releasing it again at low tide, this amount of energy would be available each half tide of, say, 6¼ hours. The tidal power was thus equivalent to about 55 kilowatts per square mile per foot rise squared. Ideal conditions could not be realised, and there would be losses in the turbines, and so we probably err on the high side if we take 10 kilowatts per square mile per foot rise squared as the maximum we might expect to be able to utilise. This would give 10,000 kilowatts per square mile with a double tidal amplitude of 31·5 ft., and 500 kilowatts for one of 7 ft. The Bristol Channel is by far the most favourable place in this country for the large-scale utilisation of the tides, and the Firth of Clyde stands next because of the large area which could be enclosed within a comparatively short distance. Beyond the limits of the British Isles, in our "Engineering Notes" of September last, we pointed out the very favourable conditions at Cape Split, New Brunswick, where there appears to be a maximum power of such tides within the Empire.

OBITUARY.

Sir Marc Armand Ruffer, C.M.G., M.A., M.D., B.Sc.—The death is reported of Sir Armand Ruffer on his way back to Cairo from Salonika, where he went a few months ago to reorganise the sanitary service of the Greek Provisional Government.

Sir Armand Ruffer was born in 1859, the son of the late Baron Alphonse de Ruffer. He was educated at Brasenose College, Oxford, and University College, London. He was formerly Director of the British Institute of Preventive Medicine, Professor of Bacteriology at the Cairo Medical School, and member of the Indian Plague Commission. For over twenty years he presided over the International Quarantine Board at Alexandria, and it was largely as a result of his administration that Egypt has been free from cholera during recent years, although it has on several occasions broken out in the Eastern Mediterranean.

He attended a number of international conferences at Paris and elsewhere as representative of the Egyptian Government, and he was recently entrusted by the Government of India with an important mission in the Red Sea in connection with securing the health of Indian pilgrims to the holy places.

He performed a great deal of very useful work in connection with the Red Cross in Egypt, and was chief of its administration in Alexandria, where an immense number of wounded men have been sent. In recognition of his public services he was created a C.M.G. in 1905, and was knighted in June last.

In 1889 he read before the Society a very valuable paper on "Rabies and its Preventive Treatment," for which he received a silver medal, and in the following year he was elected a member of the Society.

GENERAL NOTES.

Institute of Chemistry.—At a meeting held at the Institute of Chemistry on April 27th, the President and Council presented a silver rose bowl to Mr. Richard Bertram Pilcher, registrar and secretary, in appreciation of twenty-five years' faithful service. The presentation was made by the President, Sir James Dobbie, Principal of the Government Laboratories. Mr. Pilcher, who joined the staff of the Institute as clerk in 1892, was appointed assistant secretary in 1894, secretary in 1895, and has held the joint offices of registrar and secretary since 1900.

Reforesting Western Norway with Douglas Fir.—According to a report just published in the official United States "Commerce Reports," Douglas fir is recommended by Mr. Anton E. Smith, Chief Forester at Stavanger, for the reforestation of western Norway, whose former wealth of oak forest was exhausted hundreds of years ago. Mr. Smith is just returning to Norway after a year's study of American soft woods for the Norwegian Government. He spent most of his time in Oregon, Washington, British Columbia, and Alaska. The climate of western Norway is very similar to that of the States of the Pacific North-West. Accordingly, Mr. Smith recommends Douglas fir, which, he believes, if planted in Norway, will attain merchantable size in about eighty years. Norway has been cutting very heavily during the last decade, and the Government has taken effective steps to safeguard the nation's timber supply, both by encouraging reforestation and by limiting the cutting to trees above 6¾ in. in diameter, measured 5 ft. from the ground. Both pine and spruce are employed for paper-making.

New Oilfields in Chile.—Recent discoveries of oil in the territory of Magellan have created much interest, for heretofore Chilean oil has been

found only in the northern and central sections of that country. The National Association of Manufacturers (Sociedad de Fomento Fabril), in a recent Boletin, states that geological experts from various parts of the world have made tests of the oil in Magellan, and pronounce it equal in quality to that found in Argentina, and the extent of the deposits appears to rival that of the famous Comodoro Rwadavia fields. Commenting on the prospective working on an extensive scale of the oil lands in Chile, the Manufacturers' Association points out the need of legislation to regulate the well-drilling, with a view to preventing the inundation of the oil deposits by subterranean streams. The Association also advocates legislation to restrict the owning and operating of oil wells to Chileans or to foreigners settled in the country with Chilean families. The greater part of the oil lands in Magellan belong to the Government, and the Association recommends that the Government retain a royalty of 10 per cent. on all the oil produced from the lands it sells to private producers. Such a royalty is frequently stipulated for by individual owners, and it is urged that a right to a percentage should be legalised and extended to all proprietors of oilfields.

Cattle in South Africa.—The numbers of cattle in the South African Union have increased rapidly of late, particularly during the last two years. In 1911, according to the *Agricultural Journal and Small-Holder of South Africa*, the Union possessed 3,500,000 cattle; in 1914 there were 5,797,000; and the number was estimated at 8,000,000 in the first half of 1916. In 1915 South African beef fetched on the London market from 5½*d.* to 7½*d.* per lb., or from 2*d.* to 3*d.* per lb. more than it would probably have fetched before the war. The cost of exportation, allowing for the value of the by-products, is probably about 1½*d.* per lb. In order to ensure the progress of this industry, it is advisable to use bulls of a beef breed so as to obtain earlier maturity, heavier carcasses, and better adaptation for fattening. At present South African cattle are chiefly draught animals. They only attain maturity at the age of sixteen years, and their quarters weigh from 110 to 160 lb., while those of Argentine cattle, for instance, average 180 to 200 lb.

Motor Spirit from the Mhowra Tree.—The *Times of India* states that great progress has been made in Hyderabad in manufacturing motor spirit from the mahua, or mhowra, tree. The tree abounds in the State, and the authorities gather about 25,000 tons of its flowers every year. Some 10,000 tons are used for liquor, leaving a balance of 15,000 tons, which are at present a drug on the market. Several kinds of motor-car have been run successfully for some time on a spirit prepared from mahua at half the cost of petrol. The annual consumption of petrol in Hyderabad and Secunderabad is about 100,000 gallons, and only about 1,500 tons of mahua are required to make that quantity.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 14...Chadwick Public Lecture, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Professor A. Henry, "Forests, Woods and Trees in relation to Hygiene." (Lecture III.)

Brewing, Institute of (London Section), Birkbeck Café, 341, High Holborn, W.C., 7.30 p.m. Discussion on "The Restriction of Output Order—Prices and Supplies."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m.

Tuesday, May 15...Petroleum Technologists, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. L. E. Bowrey, "The Estimation of Toluene in Crude Petroleum."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Professor D. W. Thompson, "Architectural Design in Organisms. Lecture I.—The Laws of Growth and Form."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. The Secretary, Dr. Chalmers Mitchell, Demonstration of the Behaviour of Living Birds and Mammals in the presence of Snakes. 2. Mr. D. Seth Smith, Lantern Exhibition of Birds now or recently living in the Society's Collection.

Wednesday, May 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir C. Arthur Pearson, "The Blind Sufferers from the War and their Future Employment."

Aëronautical Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. L. Coatalen, "Aëro Engines."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. Messrs. J. E. Clark and H. B. Adames, "Report on the Phenological Observations for 1916."

Literature. Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. L. Courtney, "Mr. Thomas Hardy and Æschylus." (II.)

Microscopical Society, 20, Hanover-square, W., 8 p.m. Annual Exhibition of Microscopic Aquatic Life.

Thursday, May 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. A. C. Chatterjee, "The Development of Banking and Thrift in India."

Chemical Society, Burlington House, W., 8 p.m. Lecture by Mr. A. C. Chapman.

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Chromosome Theory of Heredity and the Alternatives." (Lecture I.)

Historical Society, 22, Russell-square, W.C., 5 p.m. Dr. J. Holland Rose, "The Mission of M. Thiers to the Powers (September-October, 1870)."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

Friday, May 18...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor F. Soddy, "The Complexity of the Chemical Elements."

Mechanical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. A. E. L. Chorlton, "The Construction of Turbine-Pumps."

Saturday, May 19...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "The Electrical Properties of Gases." (Lecture III.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

INDIAN SECTION.

Thursday afternoon, May 17th, 4.30 p.m.; The Right Hon. Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G., late Governor of Bengal, in the chair. A paper on "The Development of Banking and Thrift in India" was read by Mr. A. C. Chatterjee, I.C.S.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

TWENTIETH ORDINARY MEETING.

Wednesday, May 16th, 1917; The Right Hon. William Hayes Fisher, M.P., Parliamentary Secretary, Local Government Board, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Drake, John William, The High School, Middlesbrough.

Mathers, George Stanley Alexander, East India Railway House, Calcutta, India.

Stitt, Gordon Holmes, Hong-Kong and Shanghai Banking Corporation, 9, Gracechurch-street, E.C. (3)

Yung, M. H., Kwong Tung Yuch-Han Railway Company, Canton, China.

The Chairman, in opening the meeting, said that probably the members had asked themselves the question he asked himself when he was invited to preside over the meeting, viz., What had the Royal Society for the Encouragement of Arts, Manufactures and Commerce to do with blinded soldiers and their employment? The answer, in his opinion, was that all blinded soldiers were capable of arts and crafts if only they were properly encouraged and trained. Also, unless men had been forthcoming who were willing to run the risk of being blinded and maimed, to suffer and to die, the people of this country would have had no further opportunity of carrying on their arts and crafts. Arts would have been replaced by that horrible word Kultur, which was now associated with everything that was cruel, carnal, brutal and bestial. We should, without doubt, have become hewers of wood and drawers of water to our Hun conquerors, and if the war was to cost, as it probably would, four thousand millions and more, that would have been as nothing to the indemnity which the country would have had to pay, and which he supposed some foolish Huns still thought they would ultimately exact after they had sacked the City of London. The Royal Society of Arts, therefore, very rightly recognised blinded soldiers, and one who had done more for them than anyone or any number of people. Sir Arthur Pearson was a shining example of one who had found light, and found it for others out of darkness. It was not always so with the nation; the nation had not always recognised its responsibilities towards those who suffered and died for it. Our Empire and our liberties never could have been obtained unless men had been willing to endure awful suffering and hardship and were ready to give their lives for the country; but he was sorry to say that not so long ago men who went out to fight our battles and came back halt and maimed and blind, or the widows of the men who had given up their lives for the country, were not well treated. There was nothing the country was more proud of than the Egyptian War of thirty-five years ago—a magnificent episode in our history, when Egypt and the Soudan were rescued from barbarism and tyranny. If a man had been blinded in that war he would have been lucky indeed if he had 7*s.* a week granted to him to live on, even although he was a married man with a family. Many a man lost his sight in the Transvaal War, but no pension could then be obtained of more than 17*s.* 6*d.* a week. Now, however, under the new Pension Warrant, a man who was blinded in the present war must get a minimum pension of 27*s.* 6*d.* a week, and, thanks largely to Sir Arthur, he could get 20*s.* a week extra for an attendant if he needed one; while for his children he received the allowance of 5*s.* a week for the first child; 4*s.* 2*d.* for the second; 3*s.* 4*d.* for the third, and 2*s.* 6*d.* each for the remainder. If the war had brought many miseries, horrors and tragedies, it had at least brought great benefits, one being an evolution of the national conscience as to the way in which those who had fallen in the battles of the Empire should be treated.

Not so many years ago a totally disabled soldier received a miserable pittance of a pension paid quarterly, promptly often taken to the public-house to drown his sorrow, and if he died and left a widow and children they went to the workhouse. No pension was paid to the widow of any ordinary soldiers who fell in any of the Empire's wars until the Transvaal War, when the State began its system of pensions, and only then to those who were married on the strength, of 5*s.* a week to the widow and 1*s.* 6*d.* for each of her children. In the present war the widow must get at least 13*s.* 9*d.* a week, and the respective amounts for each of her children that he had previously mentioned. The cost of the revised and more generous system of pensions was estimated at 25 millions for the first year after the war—a sum which would fall year by year as the men died, as the widows either died or remarried, and as the children came off the pension list because of their age. It was a large sum, but it did not represent more than a 9*d.* income-tax. It had been estimated by the Government actuary that war pensions would cost the country 400 millions, compared with a total cost of the war of 4,000 millions. Could not the country afford to give 10 per cent. of the cost of the war in order that our national duties towards those who had made the nation what it was, and had enabled us to maintain our nation, our Empire, and our liberties, might be adequately discharged? Sir Arthur would, in his address, detail the marvellous methods which had been adopted at St. Dunstan's for recreating the blind heroes who had, when fighting, given up one of their most priceless privileges in order that the people of this country might live and prosper.

The address given was—

THE BLIND SUFFERERS FROM THE WAR, AND THEIR FUTURE EMPLOYMENT.*

By Sir C. Arthur Pearson, Bt.,
Chairman, Blinded Soldiers and Sailors Care Committee.

I very gladly avail myself this afternoon of the privilege afforded me of telling the Fellows of the Royal Society of Arts something of the cheerful, courageous, uncomplaining men of St. Dunstan's—something of the men who are so gallantly facing the handicap which has been laid upon them by the tremendous sacrifice which they have made for us and for the Empire—something of the men who in so splendid a spirit of determination are learning to be blind. St. Dunstan's has been called by many names by writers who have visited it: some have called it the Palace of Hope; it has been called the House of Great Comfort; it has been called the Home of Happiness—and the last name is the one I like the best, for happiness means so much at St. Dunstan's. It means that the men who are there are content with the lot which the fates have dealt out to them. It means that they have conquered a foe who threatened to destroy spirit as well as sight. It means that they have dragged themselves from the dark morass in which they were plunged, that they have set their feet on the flower-spangled turf which leads from the garden of endeavour back to the broad highway of normal life.

Let me take you through this Home of Happiness, as I was privileged this morning to take the Prince of Wales and Princess Mary. When you enter St. Dunstan's you will find the floors present a curious and unusual appearance. They are carpeted; but along the carpet run strips of linoleum, and these strips are to enable the blinded men to find their way about unaided. Visitors are requested not to stand about on the linoleum, nor even to walk on it. The blind men keep to the linoleum. They hear one another coming or going, and after a very few weeks—in some cases a very few days—they walk about the house with the firmness and readiness which lead a very great many people to find it very difficult indeed to believe that they cannot see where they are going. This principle of the guiding pathway is also continued in the grounds. There are stone terraces with wire pathways. In front of the steps, walls and other obstacles are boards let into the gravel, and when his foot touches the board the blind man knows there is danger ahead, and prepares himself accordingly. There are railings with marks upon them to denote turns, and there are a great many ingenious devices which tend to give back to a man that independence the loss of which is the real, and the only real, curse of blindness. With surprising rapidity the men of St. Dunstan's learn to disregard these precautions. After a man has been there a few weeks, as a rule you will find him walking about really taking no notice of the boards or pathways. Some get on better than others. The younger fellows get on better than the older ones, and a quite blind man better than those who have a little glimmer of sight. That glimmer simply confuses and troubles its possessor, and also prevents the brain from developing other senses, and it is an undoubted fact—a fact in my own experience, a fact which many men of St. Dunstan's have confirmed to me—

* The address was delivered *ex tempore* by Sir Arthur Pearson, and is here reported as delivered, being taken down in shorthand. Time has not permitted of any revision by the speaker.

that if you have got to be blind, you should make a good job of it at once and be absolutely blind. That is the way to get on.

We will go through the garden of St. Dunstan's until we come to the great class-rooms, where the men are taught to read and to write, both by methods which are quite new and quite unfamiliar to them. In these class-rooms you will find half of the men of St. Dunstan's busy in the morning and the other half of the men in the afternoon, each man sitting at a table with his individual teacher. These teachers are ladies who voluntarily come daily, in spite of any other calls, in spite of any stress of weather, to help blinded soldiers to learn to read again. No words of mine can speak too highly of the splendid manner in which they have carried out the duties which they have taken up. The organisation of this teaching department has rested with Miss E. W. Austin, the exceedingly capable librarian of the National Library for the Blind, and, as I have said elsewhere, it is impossible to bestow too high praise upon the organisation of Miss Austin or the zeal and energy of those whom she has gathered round her to help.

Time will not permit me to tell you of the intricacies of Braille reading. It is a difficult thing to learn. It is a difficult thing for a well-educated person to learn, and it will always remain to me a miracle, and it will be a miracle to all who have been familiar with the work of teaching blind people, how these, in many cases rough, poorly-educated, private soldiers, master the intricacies of Braille and learn to read again as rapidly as they do. Many of them boggle a good deal at it at first, but I try very hard to persuade them to stick at it, and it is quite wonderful how a man who for some weeks finds it is impossible to distinguish dots at all finds the difficulties disappear and everything become plain sailing.

In this, as in other things, there is not the slightest doubt that loss of sight quickens and develops the other senses. The brains of the blind man are much more actively employed than the brains of persons who can see. We blind people are always thinking; in every step we take we must think. I said to the Prince of Wales this morning: "I am afraid I am taking you about rather badly—I cannot talk to you and walk straight; if you were not here I should get about very easily." The blind man is always thinking, whether he is feeding himself or dressing himself, or whatever he is doing. I am perfectly sure that that increase of the need for thought develops the brain of the blind man just as increase of work will develop the muscles of the athlete. Whether that explanation is scientifically accurate or not I leave to you; but, anyhow, there is not in my mind the slightest doubt that the loss of sight does quicken the intelligence in other directions, and enables men to do things, both with regard to Braille reading and other pursuits and industries which are acquired at St. Dunstan's, in a manner which those same men would never have been able to accomplish had they been in full possession of their sight. Braille is exacting. We do not find it a good plan to keep men at it too long, and therefore netting has been introduced into the Braille room as a convenient department, and after a man has spent half an hour or three-quarters of an hour at Braille he has half an hour at netting. It may be properly described as a paying hobby. They learn to net hammocks, string bags, fruit nets, railway racks, and all sorts of things, and a man who avails himself of netting can make *5s.* or *6s.* a week in his spare time, besides having something with which to fill up that spare time.

The third thing taught is typewriting. That again, some people think, ought to be a very difficult thing for blind folk to learn, but it is not at all difficult. The dullest men at St. Dunstan's learn to use the typewriter; in fact, I can hardly recall an instance of a man who has failed to learn its use. Some learn it more rapidly than others. Some pass their typewriting test in a few weeks, and that means that they have written a page of manuscript and a letter at a fair rate of speed. That entitles a man to the possession of a typewriter when he leaves St. Dunstan's. A typewriter is not a superfluous luxury. The handwriting of blind people tends to deteriorate. My own writing, unless I am careful and think of every letter, is practically unreadable; but now, thank goodness, I can rattle away rapidly on a typewriter. I am perhaps busier at the moment than I have ever been in my life, and I can write more letters with my own hand than I ever did before. The typewriting lessons given at St. Dunstan's are appreciated, and that is borne out by the fact that I have received something like thirty or forty letters from men who have left, in almost every case typed as perfectly as the secretary of any business man in this room would have typed them.

Before passing on to the workshop, I should

like to tell you of three occupations which we count as the most intellectual at St. Dunstan's, one of which is taught in the class-rooms and the others close by. The one taught in the class-rooms is shorthand-writing. That, to people uninitiated in the ways of the blind world, must seem an impossible thing for blind people. It would take me a long time to explain how it is done, and I must be content with telling you that the dots which constitute the Braille system are by means of a little machine impressed on a roll of paper which looks like the paper which comes out of a tape machine. The blind operator, by the use of highly-contracted Braille, is able to take down by this system just as rapidly and just as accurately as the ordinary-sighted writer of shorthand. To-day I dictated, before the Prince of Wales and Princess Mary, a long sentence to one of the shorthand instructors who, after taking it down, read it over and typed it out as quickly and accurately as any person who could see would have done. The curious thing about this industry of shorthand-writing, as taught at St. Dunstan's, is that hitherto it has been considered in the blind world that shorthand-writing could be only acquired by people who had been always blind—people who had been brought up to read Braille just as you were brought up to read ordinary print—and I was severely chided, by people who knew a great deal more about the blind world than I did, for the idea of attempting to teach these grown men—many of them with not a very high standard of education—this very difficult art of shorthand-writing in Braille. However, I had my own ideas as to the capacity of blind people, and as to what fellows who attack the problem of blindness with the courage with which men of St. Dunstan's attack it are capable of. The result has been a triumphant success. We have already turned out half-a-dozen men, some of whom have gone back to their old posts of private secretaries, and some of whom have had new situations found for them, and in every case I have received from employers testimonials to the effect that the work of these blind secretaries is just as good as the work done by any secretary with sight that they have ever employed, and that it fulfils every standard required. Several of these men are earning higher wages than they earned before, and this is entirely irrespective of the pensions, which are not affected by any amount the men may earn.

Next to the class-rooms comes the room in which is given preliminary instruction in massage. Now here, again, is a thing which wise people thought it was entirely impracticable to attempt to teach the blinded soldier. The blind masseur has been with us for some time: but in every case hitherto the blind masseur has been a person of superior intellectual attainments, very often a person who had been in the medical profession before blindness overtook him, and the fact that I always laid down the rule that our men must be perfect in whatever they did was looked upon as a fatal bar to the blinded soldier acquiring a sufficient degree of proficiency in the difficult art of massage. This is a point I am very insistent upon indeed. Let us take the case of a piano-tuner, for example. Many blind persons earn a living as piano-tuners. Supposing you have a piano tuned by a person who can see and he damages it, you say that that person is a deceiver and you will not employ him any more; but if you have your piano tuned by a blind person and he damages it you naturally ask, What is the use of blind tuners? and away goes the whole idea that a blind person is able to accomplish useful work. It is absolutely necessary that a blind operator should be perfect. Now perfection in the case of massage means very strenuous study. Our fellows have to pass the stiffest examination there is in the country—the examination of the Incorporated Society of Masseurs. They have to acquire a thorough knowledge of anatomy, physiology, and pathology, besides gaining the manipulative dexterity which is necessary. But they have come through it triumphantly. Already twenty-four men have passed this examination and are busily at work. Most of them are employed at military hospitals, and in every case where one or more of our men have gone to a military hospital the authorities of that hospital have asked for more. I received a letter two weeks ago from the commanding officer of a hospital near Liverpool in which he says: "Your blind masseur, Cooke, has been with us now two months, and of the staff of twenty-three he is the best, and I should like you to send me three more as soon as you can let me have them." The principal of the massage department of the largest command depot in the kingdom, Heaton Park, near Manchester, told me: "Of my staff of thirty-two masseurs your four blind boys are incomparably the best there, and we want four more." I could go on repeating instances of exactly the same character.

I think you must all agree with me that it is a very amazing thing that these fellows, many of them lads with just a plain, ordinary Board School education, should be able to acquire the necessary knowledge wholly apart from the necessary dexterity which is needed to attain this high degree of proficiency. The Prince of Wales only this morning said to me: "I am very glad I do not have to memorise the Latin names of every bone, muscle and joint in my body," and no doubt many of you would feel much the same about it.

The third of what one may call the intellectual occupations carried on at St. Dunstan's is telephone operating, again a very strange thing for a blind person to learn. The blind telephone operator cannot work at public exchanges where the flash-light system is involved. He works in large buildings where the exchange lines are terminated by drop shutters, and, although these shutters are made to pattern and are supposed to be identical, after a few months' training the blind operator can tell by the sound which shutter has fallen. A good knowledge of Braille is very necessary for this industry, because it is necessary to take down messages very often and type them out and send them up to the room or the department of some member of the staff who is out. Just in the same way a good knowledge of Braille has to be acquired for massage, because in Braille are printed some of the important books on anatomy and physiology, and the better the men get on in Braille the more swiftly are they able to read and familiarise themselves with the knowledge that it is necessary for them to acquire. So, in all these things, shorthand-writing, massage and telephone operating, Braille plays a very important part, and that is the reason why I associate them particularly with the class-rooms in which Braille is taught to the men of St. Dunstan's.

Now let us pass from the class-rooms to the adjoining workshops, which have already, I am sorry to say, proved all too small. We are at the present moment finishing the erection of some large new workshops, which it is hoped will provide all the accommodation necessary. In the workshops you will find men pursuing four different industries—two of them ordinary industries to which blind people are accustomed, one of them very unusual, and one of them quite new. The ordinary ones are basket-making and mat-making. Basket-making is probably the oldest and best established and most universally used industry for the blind. It is a thing that blind people can do just as well as anybody else, and it is a thing that the men of St. Dunstan's succeed in acquiring with extraordinary rapidity. Those who have left St. Dunstan's make very substantial additions to their pensions by practising the industry at home. Many of them are making more money as basket-makers than they made at the occupation that they followed before they were blind. I think the financial aspect of the work is interesting, and so I will tell you that the worst paid of the blind masseurs is receiving a salary of £2 10*s*. a week. What one may call the ordinary occupation is mat-making. It is a well-known industry in institutions for the blind, where it is taught on looms. We teach our fellows the old-fashioned art of mat-making on a hand-frame. It has the disadvantage of being rather monotonous, but it is an occupation at which a man can quite easily make 30*s*. a week by working six or seven hours a day, and the mats turned out, as is the case with work of blind people generally, are up to the very highest standard of excellence.

The third occupation, which, although not hitherto absolutely unknown to the blind world, was very little followed, is that of boot-repairing—"cobbling" is the old-fashioned word, and "snobbing" is the pet name for it amongst the men of St. Dunstan's. The blind cobbler acquires in the short period of his training at St. Dunstan's the ability to sole and heel a pair of boots just as well as anybody in the kingdom can do it. I heard a day or two ago from a lad who started at Guildford that the result of his first three months' work as a cobbler was that he had earned on an average the sum of £1 9*s*. 1*d*. per week; and I have heard from friends in the neighbourhood that they have never had their boots and shoes soled and heeled better than he can do them. I like the cobblers to combine with their work mat-making, because the one disadvantage of cobbling is that work may come in a rush; there may be six pairs of boots to repair in one week and only one pair the next, so that if the week is a slack one the man can make a couple of mats, and also have a change in his work. Mat-making is easy to learn, and it is quite easy to dispose of the mats, and therefore all cobblers learn mat-making as well, and it is only the comparatively few dull-witted men who are not capable of doing very much who learn mat-making alone.

The unusual industry taught in the workshops is that of joinery. By joinery I do not mean that a man becomes an expert all-round joiner or carpenter; I mean that he makes useful articles with carpenters' tools. The idea was brought to my mind by hearing of an extraordinarily expert man—I think probably the most expert blind workman in this country, perhaps in the world—who lost his sight some sixteen years ago in Sheffield. He was then a thoroughly skilled carpenter. He passed through a period of two years of miserable depression, and began to believe that he could do nothing —that period which, I am thankful to say, the men of St. Dunstan's are entirely spared. He then made up his mind to take up his old work, and Atkinson, as he is called, to-day is just as good a carpenter as any man in the Kingdom. If we want anything done about the house at St. Dunstan's, Atkinson comes along and does it. If it is shelves, he comes and measures the place, and then he comes back and puts them up, and the work is as well done as by any carpenter in the kingdom. It was Atkinson's example which made me believe that something could be done by blind people who had not been carpenters. Some of the fellows who have learned this particular trade have been carpenters or something like it, but the majority of them have done nothing of the kind before. They learn to make picture frames, tea trays, corner cupboards, etc., and by the time they leave St. Dunstan's they can make these things just as well and just as accurately, and very nearly as rapidly, as the man who can see.

On the question of profits, I can give you a figure I am afraid you will scarcely believe. The best carpenter we turned out from St. Dunstan's was formerly a gamekeeper earning £1 2*s*. a week. He was a clever man, and he learned his Braille very quickly. This man sent to me not very long ago an account of his first year's work. He had earned on an average every week for that year £2 8*s*. 3*d*. The result of his next three months' work was an average weekly earning of £3 3*s*. and he is now doing a good deal better than that. We set him up in Harrow, and he has been moved to a shop just outside the school gates and the masters and boys of Harrow have been interested in him. I had a letter this morning telling me that the result of his first week's work was takings to the amount of £12 18*s*., more than half of which would be profit. It seems almost ridiculous to talk of a newly-blinded man earning as much as that by an art which one would imagine would be quite outside the reach of a blind operative, but these figures are not fanciful but facts.

Before leaving the carpenter's trade, I will give you an interesting little instance of the way in which one persuades men to do something which they do not think they are fitted for. The difficulty at St. Dunstan's is that the range of industries is obviously a small one. We do not go in for fancy work but only teach them things which we know they can make good at when they leave, and many fellows do not think that they can manage to tackle any of the different occupations, so one has to find some reason for persuading a man to have a try at something. A few weeks ago I had a very difficult task in finding something for a young Australian to do. He did not fancy anything, and so I asked him what he had done before. He said that he was a butcher. I said to him: "What are you talking about? You have a ready-made job. You have been accustomed to handle tools, to use saws and knives; now here is carpentering, the very thing for you." He said: "I think I could do that." He has become absolutely a first-rate carpenter, and will be as good probably as anyone we have turned out. Butchering and carpentering have, of course, nothing to do with one another, but it was just the opportunity of putting an idea into the lad's head—he simply wanted something to make him feel he could do a job That is perhaps the most difficult thing at St. Dunstan's, fitting the round peg into the round hole, and it is a thing about which a great deal of trouble is taken. We do not say to a man, "You look as if you would make a good basket-maker or a good boot-maker." I have a good talk with the man, and we thresh the matter out, and if necessary we bring in his wife or some member of his family to the council, and we discuss the matter, and we go on until he feels he has a job he is fitted for. Once a man feels he is tackling something he goes forward with a spirit which is absolutely undefeatable.

The remaining industry which we teach at St. Dunstan's again will seem to people who do not know the curious capacity of the blind impossible for blind people to manage, and that is poultry farming. Poultry farming has been a very great success. We have quite a number of men settled in the country who are pursuing it, so far as one can judge at the present time, with all the ability requisite to provide them

with a comfortable livelihood for the future. It is not a thing like basket-making or cobbling, at which a man can begin to make money as soon as he starts work. If he marks time in the first year and gets along in the second year and is in full swing in the third year, he is doing well; but so far as the opinion of the best experts go—and in this we have the help and advice of the best experts in the kingdom—these fellows are doing the right work. By the time a man has been through his course at St. Dunstan's he not only knows the scientific treatment of birds, how they should be managed in every respect, and so on, but he knows how to run an incubator, can tell the weight of a bird within two or three ounces, and can truss and prepare a bird for the table in a manner that would not disgrace a Bond Street poulterer, and is a complete all-round poultry farmer. We help him out in an important respect. We train one of his relatives to learn poultry farming by the same methods which are utilised in the class at St. Dunstan's. At a well-known poultry farm in the Midlands, wives, sweethearts, and mothers—in one case a brother and in another case a father—have been for a six weeks' course, and have learned poultry farming in a manner which will enable the blind soldier when he settles at home to pursue the industry which he has learned.

I have told you a good deal about the way in which these gallant blinded soldiers learn to work and the splendid spirit with which they attack the tasks that are set them. The speed with which they learn is quite uncanny. It is a literal fact that the men at St. Dunstan's learn their industries in a quarter, or even less, of the time that is considered necessary in ordinary institutions for the blind; and, mind you, besides learning those industries, they have learned to read, to type-write, to net, and to be competent in many other things. Not long ago I had a letter from the chairman of the agency that some people think the best institution for the blind in England. He asked if he might bring a deputation to St. Dunstan's to consult me on an important matter. Of course, I said yes. When they came the question they put to me was this: "We have looked at the men you have trained here who are settled in our neighbourhood, and we have seen their work and how they do it, and we have come up from the north of England to-day to ask you to tell us how it is you can teach men in six months what it takes us four years to teach them." Well, there are several reasons. One undoubtedly lies in the excellence of the raw material we have. These fellows provide the very best raw material that the blind world has ever known. It is an unfortunate fact that the average workman in workshops for the blind is apt to be something more than blind—he is apt to be physically, perhaps even mentally, defective. Such men do not provide the admirable raw material provided by the men of St. Dunstan's. But there are other reasons. My reply to the chairman was this: "Go back to your institution and abolish that horrible word affliction from it, and you can cut your time of training in half at once." That is a point on which I am very insistent. Blind people have hitherto, I venture to say, been treated entirely in the wrong manner. Sweet, kindly folk talk to them about their affliction, and the terrible difficulties which beset them. If you tell a man often enough that he is afflicted he becomes afflicted, and adopts the mental and physical attitude that befits that horrible word. On the other hand, tell him that he is only handicapped, and he may thank Providence that he is handicapped in a way which it is quite easy to get the better of, and the whole of his future assumes an entirely different aspect to him. I told these gentlemen also, that if they employed blind teachers, as we do at St. Dunstan's, they would find a very startling difference. The people at St. Dunstan's are taught by blind teachers. I am a blind teacher at St. Dunstan's, and I have under me a staff of blind teachers. We believe that the blind are the best teachers of the blind, and, provided they are in the condition to do so, the best people to care for them. We know that other folk, however kindly and sympathetic they may be, do not know anything of the blind. There is that difference. When a blind man, with that horrible feeling of helplessness which first overcomes him, particularly when he tries to do something, finds that the man who is teaching him is blind himself, he says to himself at once: "This fellow is showing me the right way—if this fellow who is blind knows what he is doing, I can do it." The most capable men at St. Dunstan's are asked to remain on as pupil teachers, and in every one of the workshops at the present time you will find blind soldiers teaching blind soldiers. Here, again, what could you imagine more encouraging to the disheartened newly-blinded man than to find his first fumbling efforts directed by a comrade who himself only lost his sight in

the firing-line perhaps six or eight months ago?

I told these gentlemen from the north of England that a great deal of the success and of the rapidity with which the men of St. Dunstan's acquired their industry was owing to the shortness of the hours they worked. That again seems odd, but it is quite natural when you come to think of it. Working under new and unusual conditions imposes a great mental strain, and if that work is kept up hour after hour the brain becomes fagged, the hand refuses to follow the impulse of the brain, and the worker is discouraged, so that it undoubtedly leads to inefficiency. At St. Dunstan's our hours may seem to you ridiculously short. The men work two hours in the morning and two and a half hours in the afternoon. There is a further period of an hour in the morning and in the afternoon when they can work, and you will usually find some fellows in the workshop, as a rule men who are finishing up a job for some reason or other. But as a general rule 95 per cent. of the men at St. Dunstan's do not work more than two hours in the morning and two and a half hours in the afternoon. Yet in an average period of seven and a half months they acquire the industries and various forms of blind art with a perfection which has nowhere been equalled in four or five times the period.

Having told you a good deal about the way in which the men of St. Dunstan's work, let me tell you something of the way in which they play; for at St. Dunstan's we attach just as much importance to teaching the men to play as to teaching them to work. If a man can play he can work. In short, you have to put the man back into normal life; you have to make him feel that he is just the same fellow as he was before in every possible respect. And, believe me, with the exception of the insurmountable difficulty of finding one's way about alone, the blind man who attacks his problem with courage and hopefulness can get on. Teaching these men to play is a great asset in teaching them to work. The men of St. Dunstan's have rowing, which is the best exercise, and which blind people can do as well as other people. When a man finds that he can do it as well as he did before, or, if he had not rowed before, can do it as well as he knows it ought to be done, up go his spirits accordingly. They play all kinds of games in the garden, tug-of-war, walking races, running races, with strings along which their fingers run, bowls, competitions in walking straight and going in different directions according to sound, and they swim. The committee of the Marylebone Baths permits us the use of the baths in the morning free of all charge, and many men have learned to swim who never attempted it when they could see. One lad, who has now left us, habitually went off a 12-ft. dive. I would not do that! He only learned to swim at St. Dunstan's. In addition to the outdoor games which these fellows learn, we teach them to play indoors as well. There is a debating club, the sessions of which are attended by on an average from sixty to one hundred members. The meetings are held every Thursday. To-morrow evening I am opening a debate the subject of which will be: "To what extent is it wise for blind people to go about by themselves?" We have a debate on some subject of interest to the blind once a month, and I always open it. They play all kinds of card games by the use of cards marked with Braille, and marked in such a way that the other fellow cannot see what you have in your hand! They learn to play chess, dominoes and draughts, and all sorts of other games, and we have competitions, many of which have been devised for them specially at St. Dunstan's, and practically all of them learn some musical instrument or other, ranging from the penny whistle and the mouth organ to the violin or piano. We have also singing. We have a very good chorus at St. Dunstan's. A hundred men from St. Dunstan's sang the third verse of "God save the King" after Madame Clara Butt, and I was told that it was quite a creditable performance. So far there has been no musical genius of the instrumental order at St. Dunstan's, but there is a man there at present who I think is going to be a singer of unusual merit. Curiously enough, he is the only man who has been to St. Dunstan's who never learned to read or write.

I must tell you something of what follows when the men leave St. Dunstan's, for I look upon their training there as only the first step—a most important step, I will grant—in what we wish to do for them to enable them to be and to remain self-reliant, competent citizens in pulling their weight in the boat as they did before. We have devised quite an elaborate system of after-care. This has been made a department of the National Institute for the Blind, of which I have the honour to be President, and it covers, I think,

as completely as can be arranged, the entire after-lives of the men in St. Dunstan's. The kingdom is divided into districts, in each of which there is a travelling superintendent. Every man is visited once every two or three weeks, and we receive reports about him from the point of view of both his industry and his home life. Then he is provided with his raw material at cost price, and of the best quality, and he is helped in the marketing of his goods either locally or from a central depot, and his work is supervised in order that there may be no deterioration in its quality. The work of the blind operative is apt to deteriorate, and if a fault becomes once well established it is very difficult to remove it again. Therefore, if one of our travelling inspectors discovers that a basket-maker's baskets, for instance, are getting a little bit out of the round, word is sent to headquarters and an expert goes off and puts the fault right, and the man goes on again making a perfect basket. The after-care department extends also to the family lives of these men. If there is sickness in the family, we see that the child or the mother, or whoever it may be, is properly attended to. A very pathetic example occurred the other day. One of our lads has only a mother, and this mother, while going over a level-crossing, was knocked down by a train, and was so injured that both her feet had to be amputated. The after-care department, after she had left the hospital, provided her with the best artificial feet that could be found, and the lad said, "Mother stumps about the house just as she used to." I am sure you will all agree with me that that after-care department is of the highest importance. There is really no point in training a blind man unless you are prepared to look after him when his training has been accomplished.

The blind workshop teachers at St. Dunstan's —the boot-makers, basket-makers, mat-makers, and every one of them—are fully skilled competent workmen, earning their £2 a week, but not one of those men, with the exception of that remarkable man, Atkinson, has been able to make a decent livelihood when he has had unaided to attempt the triple task of finding his raw material, making his goods, and selling them after they were made. Provided that a system can be devised and that it is sufficiently satisfactorily financed, so that its operations can be conducted in a proper manner, the blind home-worker can make as good a living as any other man; but he has to be helped in this way, and our after-care system is designed to help these gallant men who have given their sight for us and for the Empire.

Mr. Hayes Fisher, when speaking of the pensions of the blinded soldiers, told you that the pensions are on a very liberal scale, and I am proud to say the Pensions Minister has in regard to St. Dunstan's wiped out the local committees through whom applications had to be made, and deals now directly with us. The pensions of children are, as Mr. Fisher told you, 5*s.*, 4*s.* 2*d.*, and 3*s.* 4*d.*, and 2*s.* 6*d.* for the fourth and every succeeding child; but our after-care department will be in a sufficiently strong financial position to make that up to the even 5*s.* a child, and it is going to be made up. Furthermore, I am just about to set out to raise a fund—it will mean a very large fund—to provide that same 5*s.* a child for children who were born to men unmarried before they were disabled, and to the children of the many men who have been married since they were blinded, and the men who, I hope, are going to be married. I want all these fellows to feel that their families are comfortable and all to be in a superior position. Those men are the salt of the blind earth. They are going to be a great example to blind people, and a great example to people who are not blind. I want them to be all in a position of comfort and freed from all anxieties with regard to the up-bringing of their families, and I do not think there is going to be very much difficulty in arranging for the provision of those little children who have come or are coming to the blinded soldier. Just as the magician in the streets of old Bagdad cried, "New lamps for old," so at St. Dunstan's new hopes and new aspirations are offered for the bent and battered and broken hopes of the men who come there. And those offers have been accepted in a spirit which I am sure has never been equalled in the history of the world. These new lamps are kept well polished and well trimmed. The lights which are kindled in them are kept burning truly and well. The men of St. Dunstan's are, in short, in every sense of a phrase of which I am very fond, "making good."

Now I have taken you through St. Dunstan's. I have told you something of its people, something of their lives now and of their lives to come. We have entered St. Dunstan's by the front door and we leave it by the garden. As we walk through the garden let us stop a moment and sit down on the white seat under

the great mulberry tree at the corner of the terrace lawn, and there on a summer evening we hear the happy, cheery voices of the men walking about together or with their friends—we hear the merry laughter of the fellows running down to the lake in their sweaters and shirts to go out for a row—we hear the cheery competition of the men engaged in the various forms of sport about the lawns and fields—we hear, in short, every sound that betokens a busy, happy place. If you look on the back of the seat as you rise from it you will see these words are written :—

"The kiss of the sun for pardon,
The song of the birds for mirth,
You are nearer to God in a garden
Than anywhere else on earth."

And I believe you will agree with me that that is very, very true of the garden of St. Dunstan's.

DISCUSSION.

The Chairman (The Right Hon. William Hayes Fisher, M.P.) thought that the subject hardly lent itself to the usual discussion, and that if the suggestion commended itself to the feelings of the meeting, he would ask Mr. H. J. Wilson to propose a vote of thanks to Sir Arthur Pearson, and Mr. P. M. Evans to second the vote.

Mr. Henry J. Wilson (Secretary, Gardner's Trust for the Blind), in moving a cordial vote of thanks to Sir Arthur for his excellent address, said the work at St. Dunstan's was known all over the world; its organisation was complete in every particular; and when it was borne in mind that the organiser was a blind man, he was sure it would be agreed that the result was not only amazing but unprecedented. All those who were privileged to be present at the opening of the great bazaar in aid of blinded soldiers on the previous Monday were anxious to endorse what Queen Alexandra said on that occasion to Sir Arthur: "I thank you with all my heart for what you have done for the blinded soldiers; no other person could have accomplished it." When, some four or five years ago, Sir Arthur devoted all his talent and time to the benefit of the blind, many people felt as Keats said he did after his first reading of Chapman's "Homer":—

"Then felt I like some watcher of the skies
When a new planet swims into his ken."

They felt that, with Sir Arthur's appearance, a new luminous body had come into the skies of the world of the blind, of which he was a denizen; and they thanked him very heartily indeed for showing the world, as Professor Fawcett, Dr. Armitage, Dr. Francis Campbell, and others had done, what the capabilities of the blind were, and that blindness was not an infirmity but a severe handicap. Those interested in the blind were anxious that people should know that the blind did not require pity except in the form of practical sympathy as an incentive to vigorous action. Having worked for over thirty-five years on behalf of the blind he was more convinced than ever that the world that saw was ignorant of, or knew very little of, the world that was blind, but that ignorance was rapidly disappearing as a result of the work being done at St. Dunstan's, where so many people with sight were being brought into touch with those who had lost their sight. As an instance of the ignorance that existed, he desired to mention a case that came under his notice not long ago, when a woman with a blind son, who had just returned home after his first term at the School for the Blind, came and asked him whether it was dangerous to allow her blind boy to use a knife and fork as he demanded. She informed him that she had locked up all the knives and forks, and would only allow him to use a spoon until she had made certain whether it was dangerous or not for him to use a knife and fork.

Mr. P. M. Evans (Clerk to the Clothworkers' Company), in seconding the motion, said he could endorse most thoroughly all the mover had said in regard to the wonderful success which had been achieved by Sir Arthur at St. Dunstan's. While listening to the address he could not help contrasting the lot of the blinded soldier at present with that of his brothers blinded in previous wars. The latter passed through years of fearful depression; they had difficulty in learning a trade, and, when they had done so, of making it a success; they had no prospect of the splendid pension to which the Chairman had referred, and in several cases they had come on the pension list of the Clothworkers' Company. He had listened with amazement to Sir Arthur's description of how blinded soldiers learned massage, carpentry, mat-making, and various other industries, and the great success that had attended his efforts.

The resolution of thanks having been carried with acclamation, the meeting terminated.

GRANITE INDUSTRY OF NORWAY.

Although granite has been used in Norway for many centuries, it is only within the last forty years that the industry has assumed important dimensions and a large export trade been established. The growth of the export trade has been steady and continuous, reaching in 1913 a total of 233,439 tons.

Indirectly, too, the granite industry plays an important part in the economy of the State, giving, as the export does, a considerable profit to shipping. The importance to shipping will be seen when it is stated that in 1913, 71,000 tons were exported to Argentina alone, the freight charges being in excess of the value of the goods f.o.b. steamer in Norway.

Up to 1904 Great Britain had been the one great foreign market for Norwegian granite, exports to this country having increased from 69,289 tons in 1900 to 149,078 tons in 1904. From the latter date exports to Great Britain

began to decrease rapidly, until by 1913 they had declined to only 37.301 tons. During this period, however, other markets had been found for Norway's granite, especially in Argentina and Belgium. The two countries took in 1913 a total of 71,215 tons and 45,171 tons respectively.

According to a report by the United States Consul-General at Christiania, the Norwegian granite industry depends largely upon the export trade for its prosperity, and for this reason is confined chiefly to the district near the entrance of the Christianiafjord, between this and the Swedish frontier. Export to a less extent takes place also from the Drammen district and from Larvik of the so-called larvikite, or "labrador." The most important quarries are situated at Iddefjord, near the Swedish frontier, known as the Smaalenene district, where 70 to 80 per cent. of Norway's granite is produced. Hvaler, the group of islands at the entrance of the fjord, forms also an important district, in which many quarries are found, the largest being the Sand quarry on Skjaeren.

The Norwegian quarries are worked, on the whole, in the same manner as in other countries, although modern improvements in the way of machinery, transport rails, etc., are not so far advanced as in other places. The quarries are generally quite close to tide-water, and the granite lies near the surface and, in large tracts, entirely exposed and free from foreign material. They are consequently easily worked, and require little machinery and less handling than in other parts of the world. Only such stone as is easily accessible is worked, and it is so near the surface that deep cuttings are not required. The quarries generally are small, and it is therefore not convenient to employ much machinery.

As regards its quality, a series of tests has been made which prove that it is a very solid material with an extremely high resistance to pressure, exceeding that for granites in general. The investigations also show that Norwegian stone belongs to the best classes for quality, and stands high in its resistance to frost and surface disintegration.

The polishing branch of the industry is still in a rather primitive state. Methods that were discarded in the United States and elsewhere many years ago are still used in Norway.

The working days in the quarries during the summer months consist of 10 hours, except on Saturdays, when they are only 6½ hours, making for the week 56½ hours. During the winter months, when there are so few hours of daylight, the hours of employment are only 7 per day, or a total of 42 for the week.

Quarrymen and journeymen are paid on the average 6¾*d.* per hour, and granite cutters from 8*d.* to 10*d.* per hour. These rates, however, are very seldom used, as practically all work is paid for by the piece. Quarrymen apprentices are unknown in Norway, except in cases where a boy sometimes helps his father when doing piece-work. Granite cutters' and paving cutters' apprentices receive from 11*s.* 3*d.* to 16*s.* 8*d.* per week.

Paving cutters work entirely on the piecework system. It is impossible to state the rate of earnings per hour, as there is no supervision of the workmen and no account kept of the time consumed on each job.

The cost of transportation from the quarry to tide-water depends entirely upon the location of the quarry. In many cases there is no cost whatever, as the quarries are often situated right on the water, and a crane is all that is necessary to load the granite into the boat.

The cost per cubic foot on rough granite as quarried is as follows: Grey granite, 3*s.* 4*d.*; red granite, 3*s.* 11*d.*; black granite, 5*s.* 7*d.* The cost per linear foot on dressed curbstone is about 2*s.* 3*d.*, including the material. The cost per square foot of dressed granite surfaces is 1*s.* 6*d.* for dressing one superficial foot (ten cut). Paving blocks of an average size and finish cost 2*s.* per 1,000.

Steel used in the manufacture of tools for quarrying and cutting has about trebled in price since the war. The powder used costs about double as much as in normal times.

While some other industries in Norway are enjoying great prosperity, the granite industry has been severely hit by the war. With the increased cost of building materials and labour, building operations have practically ceased. Very few building contracts are being made, and therefore the demand for building stones is small compared with what it was in former years. The export trade has been greatly hindered by the high freights which have prevailed since the outbreak of war. Only about 10 per cent. of the workmen normally employed in this industry are at present occupied.

NEWFOUNDLAND FUR INDUSTRY.

There appears to have been no important increase in Newfoundland's fur production during 1915, but since the beginning of the war many of the pelts that formerly went to Canada and Europe have seemingly been diverted to the United States.

Official statistics of production are not available, but the yield probably approximates 100,000 pelts, of a value of about £60,000 (exclusive of seal pelts, which would raise the total to over £100,000). It is difficult to estimate the production, because some of the Labrador pelts passing out through Canadian channels are doubtless regarded as part of the Dominion's output.

Of this production not more than one-third has been shipped direct to the United States in the past. Since the beginning of the war exports to the United States seem to have fully doubled; in 1915 they probably exceeded £40,000 in value. Most of the shipments

appear to have gone *viâ* St. John's, though the bulk of the island's fur yield comes from a region nearer to Bay of Islands than to that port.

According to a report by the United States Consular Assistant at Bay of Islands, it is doubtful whether anywhere near the maximum yield of fur is at present being obtained. The supply of fur-bearing animals seems plentiful, and there apparently is opportunity for much more trapping than is done. Trapping is much more extensive on the Labrador Peninsula and in the northern part of Newfoundland than around Bay of Islands. In the latter district the trappers range comparatively short distances from the coast, and have hardly penetrated a broad interior region that, when invaded, will most likely be found a profitable field.

Newfoundland has wisely decreed closed seasons for many of the fur-bearing animals, but the island is well suited for the adoption of positive as well as negative means of increasing its available supply of furs. Experiments elsewhere have indicated that the breeding of impounded wild animals for their pelts is profitable, and in that part of Newfoundland around the Bay of Islands there are large tracts of uncleared land suitable for wild life, yet not far distant from the coast settlements. Such discussion of the matter as there has been in the public press has recognised that the island is well adapted for this industry. Two years ago a prominent attorney suggested an amendment of the game laws to encourage the private rearing of beavers. As the beaver is not plentiful anywhere and as its fur commands good prices, the raising of this animal should be profitable. However, so far as is known, very little has been done in Newfoundland except in breeding foxes.

In the Bay of Islands district there was much interest prior to the war in fox farming. This industry had received considerable impetus in 1913 and the early part of 1914. Had it been founded solely, or even in large part, upon the rearing of foxes for their pelts, it would now undoubtedly be on a firm and prosperous basis, instead of being almost ruined by the war.

Fox farming in Canada and Newfoundland has been confined largely to the production of silver foxes. For the information of those not acquainted with the business, it may be stated that the fur of the "silver" fox is jet black with scattered white hairs, and such pelts are worth more than other varieties. It was said in 1913 that the record price for a silver pelt was £560; from that amount prices ranged downward for good furs to about £60, the average being probably much nearer the latter than the former figure. Some proprietors have numbers of "patch" and red foxes on their farms, not for the reproduction of their kind, but, by cross-breeding, to produce "silvers."

Until 1910 there does not appear to have been any demand for live foxes in Newfoundland, except from Canadian buyers who had for some time obtained in the island many animals for breeding stock at prices quite commensurate with the values of fox pelts. About the year mentioned Newfoundland practically abandoned the hunt for silver fox pelts for the capture of live "silvers," or of foxes that might be crossed for breeding silvers. The prices for such live animals were then rising considerably above the value of the pelts. Many sales had been consummated at high figures before general attention was given to fox farming.

In order to prevent Newfoundland from being drained of breeding stock, an embargo was placed upon the exportation of other than ranch-grown live foxes. With the conservation of its supply of wild foxes, it was felt that there would be sufficient to ensure an industry second only to that of Prince Edward Island. Scores of fox farms were set up, but there was not that knowledge of the essentials of fox breeding necessary to success. On some of these small farms the animals did not breed at all, and on others the litters were not saved. Many trappers sank time and money they could ill afford in such attempts. Even before the war began many of the small enterprises were abandoned, and trappers were urging the removal of the embargo so that they could benefit from open Canadian competition.

Other farms were understood to be maintained by Canadian buyers, who thus sought to comply with the Newfoundland law and to create there a supply of ranch-bred animals. Retrenchment forced the discontinuance of some of these Canadian-owned Newfoundland farms, and general depression in the early days of the war eliminated most of the small and some of the large Newfoundland-owned farms.

For the ranching of fur-bearing animals Newfoundland has decided advantages. Not the least of these is its climate, the summers not being warm enough to be a burden, and the winters making for prime fur. Fortunately, a few farms are still maintained in the island, principally those conservatively organised, and a few proprietors maintain their confidence in the industry. Some are taking advantage of the present slackness to add to their supply of breeding stock. These few farms may be the nucleus of what will ultimately add much to the island's wealth. It seems unlikely, however, that the industry will regain its speculative importance.

If the production of silver foxes in Newfoundland proves successful, it is hardly likely that the breeding of fur animals will be confined to that one species. Even at prices for breeding stock commensurate with the value of silver fox pelts, considerable investment and risk are necessary--much more than in connection with such animals as musquash, beaver and skunks. With them, numbers make up for lower individual values.

CORRESPONDENCE.

THE MHOWRA TREE.

The extract from the *Times of India*, in the *Journal* of May 11th, is of greater interest than stay-at-home English readers may be aware. "Mhowra," or "Mohwah," is the Anglo-Indian form of the popular Indian names, *mahua*, Hindi, and *moha*, Mahratti, deformed from the original Sanskrit, *madhuka*, given especially to the Sapotads yielding an alcoholic spirit; and meaning trees that "cheer," "intoxicate," and "madden." The Sanskrit *mad* [our very own "mad"] occurs also in the names of other Indian trees and plants; simply because of the grandeur of the growth of the trees, or the beauty of the flowers of the plants; and in one of the names of Spring-tide, the season of the loveliest indigenous Indian flowers; and also in one of the names of heavenly counterpart of the terrestial River Ganges—"the Gower"—and in one of the names of the Hindu Caped; while in its duplicate form of *madaumust* it signifies "outrageousest lustiness."

There are in India at least five recognised Sapotaceous *madhukas*, all of the genus Bassia, so named after Ferdinand Bassi, Curator of the Botanic Garden of Bologna, about 1774. The "*Shea* tree," discovered by, and named after, Mungo Park, is also a Bassia. The notable feature about them all is their great independence of the terrible vicissitudes of tropical and sub-tropical climates; those in India never having been known, however scanty the rainfall, to fail in yielding an abundant harvest of flowers; which provide not only the spirit distilled from them, but a most palatable and most nourishing food, and the well-known fatty oil pressed from their large smooth seeds. For this reason, notwithstanding the value of their timber, they are never cut down by the people of India themselves until they are on the point of dying a natural death. The two widest-spread Indian species are the *Bassia latifolia* of Roxburgh, found chiefly throughout the Presidency of Bombay, and in the Province of Central India, and the *Bassia longifolia* of Linnæus of the Presidency of Madras, where it clings chiefly to its lofty western sea-board.

Nothing was more delightful when travelling in Western India, before the days of railways, than to pitch your tent in the early morning in the shadow of a thick grove of *madhukas*, except when the cold season followed on "the Rains" and you set it up under the feathery foliage of the golden-tasselled *babulha* [from Sanskrit *varvara*, that is "covering" tree], the *Acacia Arabica* of botanists.

GEORGE BIRDWOOD.

May 11th, 1917.

OBITUARY.

SIR ARTHUR LASENBY LIBERTY. — Sir Arthur Lasenby Liberty died on the 11th inst., after a short illness, at his country residence, The Lee Manor, near Great Missenden. He was born at Chesham in 1843. His father, Arthur Liberty, was a lace manufacturer at Nottingham, and the son was educated at the University School there. Entering business in London, he became the founder and chairman of the well-known firm of designers and makers of artistic fabrics. His laudable and successful efforts to raise the artistic standard of goods for the home and for personal wear brought him the friendship of such men as Whistler, Rossetti, Burne-Jones and William Morris, who took a warm interest in the movement of which he was the pioneer. Sir Arthur did much to encourage the importation of textile fabrics from the East, and he also took an active part in reviving the British silk industry which in his youthful days, was in a decadent condition.

Sir Arthur became a member of the Royal Society of Arts in 1883, and he made several valuable contributions to its proceedings. In 1890 he read before the Foreign and Colonial Section a paper on "The Industrial Arts and Manufactures of Japan"; ten years later he read a second paper on "English Furniture" before the Applied Art Section, and in 1904 he read a third paper on "Pewter and the Revival of its Use." For each of the first two papers he received the Society's silver medal. In addition to this he took part in discussions on various occasions, and he also presided at the meeting in 1913, when Mr. H. V. Lanchester read a paper on "The Design and Architectural Treatment of the Shop."

In 1913 a knighthood was conferred on him in recognition of his services to the applied and decorative arts of the country. He filled many public appointments. He was Deputy-Lieutenant and county councillor of Buckinghamshire, High Sheriff of the county in 1899, and a member of many learned and artistic societies.

FREDERICK ROWLAND HAZARD.—Mr. Frederick Rowland Hazard died at his residence in Syracuse, U.S.A., on February 27th, in his fifty-ninth year.

He was born at Peace Dale in 1858, and was educated at the Mowry and Goff English and Classical High School in Providence, and at Brown University. After graduating in 1884 he went to Europe for a year, which he spent in France, Germany and England, studying the manufacture of alkali. On returning home he became assistant treasurer, and four years later treasurer of the Solvay Process Company of Syracuse. He succeeded his father in the presidency of the corporation on the death of the latter in 1898.

Among other business activities Mr. Hazard was treasurer of the Split Rock Cable Company, treasurer of the Tully Pipe Line Company, treasurer of the Semet Solvay Company (coke ovens), treasurer of the By-Products Corporation, president of the Solvay Collieries Company, president of the Syracuse Trust Company, director of the Commercial National Bank of Syracuse, First National Bank, Onondaga County Savings Bank,

and vice-president of the First National Bank of Tully, New York. He was also keenly interested in music, and was president of the Syracuse Music Festival Association since its organisation in 1900. He had been a delegate to many State Republican Conventions, and was delegate at large from New York to the National Republican Convention at Chicago in June, 1908.

Mr. Hazard was elected a member of the Royal Society of Arts in February last.

GENERAL NOTES.

SANDALWOOD OIL INDUSTRY IN MYSORE.—The *Pioneer Mail* draws attention to the development of an industry which has sprung up in India as the direct result of the war. Prior to the outbreak of hostilities the State of Mysore derived a considerable revenue from sandalwood which was disposed of at periodical sales, principally for shipment to Germany. With the advent of war buyers failed to appear at the sale, and Mr. Alfred Chatterton, Director of Industries and Commerce, accordingly sought the assistance of the chemists of the Indian Institute of Science at Bangalore, with a view to establishing a sandalwood oil industry in Mysore, and thus utilising the raw material formerly shipped to Germany. As the outcome of the experiments made in the laboratory at Bangalore, it was found practicable to inaugurate such an industry, and within a brief period the works were so greatly extended that the manufacture of the oil is now yielding a monthly revenue of Rs. 1½ lakhs. The co-operation of the Institute of Science was essential to this development, and the profits derived from the industry within a single year will almost equal the whole amount so far expended on the institute. The value of a well-equipped scientific institution is forcibly illustrated in this case. Sandalwood, which was formerly exported for the manufacture of oil, is now profitably treated in India, and the loss of the German manufacturers means a corresponding gain to an enterprising Indian State.

TELEGRAPH DISTURBANCE BY THE LÖTSCHBERG ELECTRIC RAILWAY.—*Engineering* gives some account of the disturbance which was caused to the service on all the Swiss telegraph lines converging at Brig, in the Rhone Valley, by the opening of the Lötschberg Railway in 1913. The railway runs from Brig on the Rhone, at first fairly parallel to the river on the slopes of the northern bank; about ten kilometres west of Brig, at Hothen, it turns to the north, away from the river. The disturbances were particularly strong during the ascent of the electric trains. All the telegraph lines in the district are single line with earth return. To reduce the disturbances the telegraph department shifted the earthing of the telegraph lines from Brig to Fiesch, about sixteen kilometres east of Brig—that is, away from the electric line, the new line to Fiesch being double. Little was gained by this. An investigation was then undertaken, and the report was published in the *Elektrotechnische Zeitschrift.* Very striking oscillograms were taken. It was found that the disturbances were almost entirely electrodynamical; current leakage to earth had very little to do with them. The remedy proposed is rather striking. The earthing of the telegraph lines was again shifted experimentally, not away from the electric railway to the east, however, but in the opposite direction. From Brig the Rhone flows westward to Visp, Gampel, and Turtmann, all on the State line. When earth was made at Visp the disturbances were reduced by 50 per cent.; at Gampel by 85 per cent.; and at Turtmann, which lies a little beyond the point where the electric railway turns northward, the disturbances practically vanished. The connection between Brig and the point at which earth was made was by a special insulated line.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 21...Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Lieut.-Col. G. Mackinlay, "The Emphasis of St. Luke."

Chemical Industry, Society of (London Section), Birkbeck Café, High Holborn, W.C., 8 p.m. Mr. M. C. Lamb, "The Commercial Utilisation of discarded Army Boots and other Waste Leather."

Geographical Society, Burlington-gardens, W., 5.30 p.m. Annual General Meeting.

TUESDAY, MAY 22...Royal Institution, Albemarle-street, W., 3 p.m. Professor D'Arcy W. Thompson, "Architectural Design in Organisms. Lecture II.—Laws of Growth and Form."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Captain F. R. Barton, "Tattooing in South-Eastern New Guinea."

WEDNESDAY, MAY 23 ... Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Professor J. Fitzmaurice-Kelly, "Góngora."

Dante Society, Mansion House, E.C., 4 p.m. Addresses on "The Spirit of Nationality and Italian Aspiration."

THURSDAY, MAY 24 ... Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 3 p.m. Anniversary Meeting.

Geographical Society, Kensington-gore, W., 5.30 p.m. Dr. J. F. Unstead, "The Resources and Future of British Columbia."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. Bateson, "The Chromosome Theory of Heredity and the Alternative." (Lecture II.)

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 5.30 p.m. Annual General Meeting.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. W. R. Ingalls, "Shall Great Britain and America adopt the Metric System?"

FRIDAY, MAY 25...Royal Institution, Albemarle-street, W., 5.30 p.m. Mr. J. Barcroft, "Breathlessness."

Physical Society, at the Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Messrs. C. C. Paterson, J. W. T. Walsh, and W. F. Higgins, "An Investigation of Radium Luminous Compound." 2. Mr. F. J. W. Whipple, "The Resistance to the Motion of a Lamina, Cylinder, or Sphere in a Rarefied Gas." 3. Dr. C. H. Lees, "The Effect of Stretching on the Thermal and Electrical Conductivities of Wires."

SATURDAY, MAY 26...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "The Electrical Properties of Gases." (Lecture IV.)

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FRIDAY, MAY 25, 1917.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, April 19th, 1917; SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., Member of the Viceroy's Council, 1910-15, in the chair.

The paper read was—

THE RECENT INDUSTRIAL AND ECONOMIC DEVELOPMENT OF INDIAN FOREST PRODUCTS.

By R. S. PEARSON, F.L.S., of the Indian Forest Service,

Forest Economist at the Forest Research Institute, Dehra Dun, India.

THE FOUNDATION OF ECONOMIC FORESTRY IN INDIA.

The gradual development of the resources of the State forests of India, on the commercial side, has been in progress for over half a century. The foundation of this work was laid by Mr. J. S. Gamble, C.I.E., F.R.S. (of the Indian Forest Service), by his study of the character, uses, mechanical properties, etc., of many of the species of timber found growing in the forests. The result of his labours, which extended over the whole of his service in India and were continued after he retired, was the publication of a volume entitled "A Manual of Indian Timbers," which to this day remains the standard work on the subject. In the early days of the department, until the forests had been properly demarcated and placed on a sound legal basis, little could be done either to introduce scientific management or to utilise anything but limited quantities of the better-known timber-yielding species. Then, again, many of the forests were handed over to the department in a ruined or half-ruined state, which necessitated careful protection for many years, and allowed of only very light improvement fellings being carried out.

RECOVERY OF FORESTS UNDER STATE MANAGEMENT.

More than half a century has elapsed since some of the forests have come under State management. This has allowed them to recover gradually from their maltreatment, and, as by degrees the superior and subordinate staffs of the department have been strengthened, more scientific and intensive management has become possible, which, with the ever-increasing commercial prosperity of the country, has brought prominently to the fore the vast possibilities of developing new forest industries.

As the forests gradually came under systematic management, to the commercial side of the business was given more attention, which resulted in the erection of sawmills, a turpentine and rosin factory of modest proportions, and from time to time the installation by the railway authorities of experimental plants for the antiseptic treatment of sleepers. The initiation of such enterprises was generally due to the energies of individual officers, and was not the outcome of a preconceived policy of Government.

CREATION OF THE FOREST RESEARCH INSTITUTE.

It was not till 1906 that the Government of India, at the instance of Sir Saint-Hill Eardley-Wilmot, the then Inspector-General of Forests, embarked on a scheme by which it was hoped to further the scientific working of the department, so as to encourage more intensive management in the forests and to further the development of forest industries. The scheme contemplated the erection of a Forest Research Institute, consisting of five branches, namely, Sylviculture, Botany, Forest Economy, Chemistry and Zoology. Later, the services of pulp and tan experts were made available. This Institute has lately been completed, and supplies a long-felt want.

Field of Research.

The scope for the development of forest industries covers a wide field and embraces many widely divergent subjects for research, of which only a few could be taken in hand as a commencement. Of these may be mentioned the manufacture of matches, the preparation of paper pulp, and the antiseptic treatment of timber, with special reference to sleeper woods. Later, it has been found possible to start investigations on other subjects, which will be briefly mentioned hereafter.

Manufacture of Matches.

The first inquiry of any magnitude undertaken was in connection with the match industry. Mr. R. S. Troup, the then Forest Economist, sent specimens of many species of timber to Europe to be tested, and, after inspecting various areas, selected factory sites near the source of supply of suitable timbers. He also collected information as to the supply of chemicals, studied the state of the markets, etc., and published a Forest Memoir* incorporating the results of his labours. Before this investigation was carried out a few match-factories existed in India, though they were at that time only in an experimental stage. Since then several new and much larger factories have come into existence, and the industry may now be considered to be established in that country.

The number of species of Indian timbers which were originally classed as suitable for splints and match-boxes was considerable, though, with the exception of Himalayan silver fir (*Abies Pindrow*), and spruce (*Picea Morinda*), none of them can claim to be of the first quality. The most universally used timber at present is simul (*Bombax malabaricum*), which is excellent for boxes, but which produces a somewhat inferior splint, of poor colour and strength. *Boswellia serrata* timber is also used, but it is hardly equal to simul timber for this purpose. The solution to manufacturing matches of the first quality in India lies in the use of the Himalayan silver fir and spruce. The difficulty in the way of such a proposition is extraction, as these species occur at high altitudes in the Himalayas, while many of the trees are of great size. To overcome this, it is probable that mechanical means of extraction, such as wire rope-ways or light tramways, will have to be adopted, combined with the erection of portable splint-making machines in or in the vicinity of the forests, whence the splints will be exported to central places in the plains, and there made up into matches. In this way the question of transporting the logs over long leads in difficult country will be overcome, there will be a saving in freight by having to carry the splints only in place of the unconverted timber, while the chemicals and other articles necessary to carry on work can be railed direct to the factories.

The Manufacture of Paper Pulp.

The manufacture of paper in India is not a new industry, it having been started by the erection of a mill near Bombay in 1862, now known as the Girgaum Paper Mill. Another mill was started at Bally, near Calcutta, in 1872. Since then the industry has developed, so that at the present time there exist at least four large paper mills, which not only manufacture paper, but also part of their pulp requirements, namely, the Titaghur Paper Mills, Ltd., near Calcutta, which is the largest mill in India; the Bengal Paper Mills, Ltd., at Raneegunge; the Couper Paper Mill, Ltd., at Lucknow; and the Deccan Paper Mills, Ltd., near Poona. Their gross out-turn was about 25,000 tons per annum in pre-war times, the output having somewhat increased since 1914. The imports of paper into India in 1914–15 amounted to 51,390 tons, valued at £709,372—a state of affairs which clearly indicates that India is not self-supporting in this respect.

The most universally known raw material used for the manufacture of paper pulp in India is a grass known as "sabai" or "bhabar" (*Ischæmum angustifolium*), which grows on the warm slopes of the hills in Bihar and Orissa, the Nepal Terai, the outer Himalayas of the United Provinces, on the southern slopes of the Siwaliks of those Provinces, and in parts of Bengal. Other raw materials used are waste jute, ropes, old gunny bags, and a limited amount of old paper and rags. The remainder of the pulp utilised for the manufacture of paper by the Indian mills consists of imported mechanical and sulphite spruce pulp, the imports of which in 1912–13, *i.e.* in pre-war times, amounted to 13,250 tons.

From what has been said above, it is clear that India could with advantage look round for other raw materials with which to make all its own pulp. To do so one would naturally turn to the many varieties of timber from which to select a suitable raw material for this purpose. This is, however, hardly possible as, owing to

* "The Prospects of the Match Industry in the Indian Empire, with Particulars of proposed Match Factory Sites and Woods suitable for Match Manufacture." ("Indian Forest Memoirs," Economic Products Series, Vol. II. Part I.)

the sporadic growth of most of the possibly suitable species—certain conifers excepted—the cost of collection is excessive, while almost without exception the amount of timber available in any one locality of one or even more than one species, is insufficient to justify the erection of a pulp mill. Under the circumstances it was necessary to look elsewhere for a suitable raw material, and the choice lay between bamboos and elephant or coarse grasses.

It was determined first of all to start the inquiry on bamboos, as at that time valuable work had been already carried out in Burma by Mr. R. W. Sindall, an expert brought out from England in 1905 by the Burma Government to investigate the possibilities of starting the industry.* Moreover, at about the same time as Mr. Sindall was working in Burma, Mr. W. Raitt commenced investigations on his own account in Southern India. Later, this expert was attached to the Forest Research Institute, where he has carried out some useful research work in the laboratory.† In 1910 a new inquiry was started by the Forest Research Institute, which was virtually a continuation of Sindall's work, who had proved the value of the bamboo as a fibre-yielding plant in the laboratory, but had not up to that time convinced the commercial world as to the possibility of manufacturing pulp on a commercial scale.

The further investigation carried out by the Forest Economist consisted in visiting suitable bamboo areas in Burma and on the West Coast of India, estimating outturn and cost of extraction by personally collecting data and figures from sample plots, selecting suitable factory sites, going into the question of labour, water supply, chemicals, etc., and submitting considerable consignments of four species of bamboo to an Indian mill to be converted into pulp and paper, so as to ascertain quality and the cost of production. The results of this inquiry were incorporated in a report printed on the paper made from *Bambusa polymorpha*. The results obtained were highly satisfactory, both as regards quality and cost of manufacture, and have resulted in more than one lease being taken up in India and Burma for the extraction of bamboos for the manufacture of paper pulp.

Little progress has as yet been made in the erection of factories, as under war conditions plant is not obtainable, though there can be little or no doubt that the industry will go forward as soon as normal conditions are established, not only for the manufacture of pulp for Indian consumption, but also for export.

In 1910 Mr. R. S. Hole, the Forest Botanist, and Mr. W. Raitt, the Cellulose Expert at the Forest Research Institute, started an inquiry into the value of certain elephant grasses for the manufacture of paper pulp. The first step to be taken in such an inquiry was to identify the various grasses and study their mode of growth. This part of the work fell to Hole.

The analyses of the grasses were taken up by Raitt, and the results of his work are given in his report,* with a foreword by Hole on the identification and mode of growth of the grasses under investigation. This report established the value of certain grasses for the manufacture of paper pulp, and as it was known that large quantities were available from parts of the United Provinces, Bengal, Assam, and Burma, it was thought necessary to obtain definite information as to outturn and cost of extraction from stated localities, and to send—as was done in the case of the bamboo inquiry—a consignment of the dominant grasses to be converted into pulp and paper in order to ascertain the cost and quality of production. This portion of the investigation fell to the Forest Economist, who proceeded to Assam in 1916, selected areas for valuation, and inspected possible factory sites, sent the necessary grass to be treated, and supervised the conversion of the grass at the mills on behalf of the Indian Government. The results of this investigation proved satisfactory, as it was found that these grasses, especially *Saccharum spontaneum*, *Saccharum Narenga*, and *Phragmites Karka*, occurred in abundance and could be extracted cheaply, while the pulp prepared from the stems, especially that of the former species, was of fair quality. On the other hand, it was found that the leafy tops of all the grasses were difficult to deal with, as the digestion was irregular and bleaching difficult, and that only "brown" could be manufactured from them. There is no doubt whatsoever that were a few hundreds of tons of these raw materials to be treated, instead of twenty tons of each, as was the case—in other words, with further experience—the results could be greatly improved upon. The report on the Assam

* "Report on the Manufacture of Paper and Paper Pulp in Burma," by R. W. Sindall, F.C.S. (Superintendent, Government Printing, Burma, 1906.)

† "Report on the Investigation of Bamboo as Material for Production of Paper Pulp," by W. Raitt, F.C.S. ("Indian Forest Records," Vol. III. Part III. 1912.)

* "Report on the Investigation of Savannah Grasses as Material for Production of Paper Pulp," by W. Raitt, F.C.S., and R. S. Hole, F.C.H., F.L.S., Forest Botanist. ("Indian Forest Records," Vol. V. Part III.)

experiments—that is, the results of the field work and the conditions under which the pulp and paper were prepared—has not been published, as the investigation is as yet not complete. Further study as to the effect of cropping these grasses is necessary, while it is thought that possibly an even aged crop will yield better results in the mills than the uneven mixed crop of grasses with which the experiments were carried out.

There is no doubt that both bamboos and certain elephant grasses may in the future play a prominent part in the paper-pulp industry of the world, as they present no great difficulties in extraction, while from their mode of growth and quick reproduction they have an enormous advantage over wood, which takes many years to come to maturity. It appears, therefore, taking all factors into consideration, that there exists a large field for future development, working with either bamboos or elephant grasses as a raw material in the manufacture of paper pulp.

Antiseptic Treatment of Timbers.

India has in the past stood in a unique position as regards its supply of railway sleepers, due to the fact that a sufficient supply of durable sleeper woods was available which required no treatment before being laid in the line. Some eight or ten years ago the supply of "sal" (*Shorea robusta*), "deodar" (*Cedrus deodara*), "pyinkado" (*Xylia dolabriformis*), and "nahor" (*Messua ferrea*), the standard sleeper timbers of India, began to fall short of the demand—not that the supply was in any way reduced—owing to the expansion of the railway systems. To meet this ever-increasing demand, and a corresponding rise in prices, the railway authorities had two alternatives—one to import sleepers, which they did to a large extent from Australia, and more recently from British Columbia, the other to treat hardwoods of insufficient durability in their natural state.

This state of affairs opened up great possibilities for developing the resources of the Forest Department, and a detailed investigation was at once instituted by the Forest Research Institute. The first step to be taken was to ascertain the possible outturn of those species which, being mechanically suitable for the purpose, could be obtained in sufficient quantities to justify further investigation, and which could be extracted at a working figure of cost.

The next step was to carry out laboratory experiments, based on sound accepted principles of treatment, an initial start being made in April 1909 by R. S. Troup, and elaborated by the writer, after having taken over charge of the Forest Economic Section from that officer, in the following month of the same year. In order to obtain a true comparison of the value of the various antiseptic solutions to be tested, twelve species of timber were chosen, varying from extremely perishable to durable, two specimens of each species, in the shape of stake, being prepared, one destined to be treated and the other not, the latter to stand as a basis of comparison. The antiseptics chosen for trial were divided into coal-tar creosote and petroleum products, salts, and a combination of salts and oils. The first specimens to be laid down were treated by the Powell process, then in order timber specimens were treated with *Avenarius carbolineum*, *Jodelite*, *Atlas*, *Solignum* and *Green oil*. Later, further series of posts were treated with *Bellit*, *Chloride of zinc* and *Sodium fluoride*, *Créosoyle*, *Hylinit*, *Crésol-calcium*, *Anthrol anticide*, *McDougal's insecticide*, *Mortant*, Crude earth oil, *Burnetizine*, *Aczol* and *Barol*. The Powellised specimens were laid down six years ago, the others about two years ago.

A note embodying the results of these experiments has recently been prepared, and will shortly be sent to press. Generally speaking, the oils have given better results than the salts, which is as might be expected, as the salts are apt to be leached out of the timber by excessive moisture. Again, the lighter boiling-point oils have not answered so well as those containing heavier fractions, as, for instance, Green oil.

The above-described experiments, owing to their nature, could not be expected to convince the public of the value of treatment, nor could they even afford the roughest clue to the cost of treatment. It was, therefore, decided to supplement these experiments by field experiments, which contemplated treating five species of timber with four different antiseptics, and to hand over the treated sleepers, free of charge, to the State railways, to be laid in the line and kept under careful observation. The experiment was to cover a period of four years, one batch of sleepers being treated each year The total number of sleepers to be treated was fixed at 20,000, of which a thousand of each of the five species of timber were to be treated each year. The species selected for treatment were *Pinus longifolia*, *Pinus excelsa*, *Dipterocarpus tuberculatus*, *Dipterocarpus alatus*, and

Terminalia tomentosa. While the first year's work was to consist in Powellising the sleepers, the next batch was to be treated with *Avenarius carbolineum* oil, the third with Chloride of zinc and a coating of Green oil, and the last with a mixture of a good grade of creosote and crude petroleum oil, mixed in equal quantities. The experiment has been carried out in detail, with the exception that for one reason or another it was only found possible to treat 7,930 sleepers instead of 20,000, as at first contemplated. The oldest sleepers have been five years in the line, the last batch hardly a year.

The results to date are satisfactory, though the sleepers have not yet had time to demonstrate the true value of the treatment; still it may be noted that while *Pinus longifolia* lasts two and a half years at most in an untreated state, it has only been found necessary to remove two or three Powellised sleepers after five years, and those for mechanical and not physical defects. The other species are more durable than the above pine and last for four to five years in an untreated state, while *Terminalia tomentosa* may last up to eight or ten years in exceptional cases.

All the above sleepers were treated in open tank with long immersion periods.

To supplement these experiments, no pressure plant being available at the time in India, sleepers were sent to England for treatment, both by the "full-cell" and "Rüping" processes, and afterwards returned to India and laid in the line. They have not been down long enough to allow of an opinion being passed as to the value of the respective methods of treatment, though they are all doing well. An up-to-date experimental pressure plant is now being procured from England, so that in future all necessary experiments will be carried out at the Forest Research Institute.

As an outcome of this movement to treat sleeper woods in India, three open-tank treating plants have been erected by the United Provinces Government in which *Pinus longifolia* sleepers are treated in creosote and petroleum oil mixed in equal quantities. The State railways are also considering the erection of a pressure plant on the North-Western Railway.

Other schemes for treating *Dipterocarp* sleepers from the Andamans and Assam are also under consideration, and may be expected to mature after the war, when treating plants are again procurable.

The scope for treating, not only sleeper woods, but also posts, constructional timber, mining props, etc., in India is very great and treatment is also very necessary, for though the forests are under careful control, the ever-increasing demand has forced up prices to breaking point; so that unless we make the most of our valuable timbers and bring on to the market our less durable timbers after treatment, the questions of heavy imports will have to be faced.

Any person with the most rudimentary knowledge of treating timber might with justice criticise the necessity for adopting such systems of treatment as mixing Chloride of zinc with small quantities of creosote, or again, ask why creosote should be mixed with petroleum oils. The answer is, that all creosote has to be imported and costs about 1*s*. 4*d*. per gallon at a treating centre in India, so that every effort has to be made to reduce the cost of the antiseptic. A good grade of creosote has recently been produced in India, but at a relatively high price, which, however, can no doubt be reduced. As soon as a good grade of coal-tar creosote is obtainable in India at a reasonable figure, it is anticipated that the antiseptic treatment of timber will advance by leaps and bounds, while a new industry will come into existence by the manufacture of creosote.

Rosin and Turpentine Industry.

An industry which was started many years ago on a modest scale was that of the production of turpentine and rosin from "drip," obtained from *Pinus longifolia.* As a commencement direct fire stills were employed, and for many years no alteration was made in this system of working. In the last six years great developments have taken place in that industry: the United Provinces Government has erected a steam distillation plant at Bhowali, near Naini Tal, which is capable of handling about 3,000 tons of crude rosin annually, while the Punjab Government has purchased an up-to-date French plant, of about 1,000 tons capacity, which has been erected near Lahore. Improved methods of tapping have been evolved by the United Provinces and Punjab Forest Officers, Messrs. Symthies and Gibson, respectively, being largely responsible for the development of the industry, while Mr. Puran Singh, the Chemical Adviser to the Forest Research Institute, has also contributed a valuable share to the work. The result of this movement has been a heavy drop in American imports, and the commencement of a modest but promising export trade. The industry is capable of still further development in the *Pinus longifolia* areas, and can probably

be extended to Assam and Burma in connection with the excellent "drip" obtained from *Pinus Khasya*.

Tan Extracts.

It is thought that there is a good opening for the preparation of tan extracts from Mangrove barks. The Mangrove forests are found extending over large areas on the Aracan, Bassein, Tavoi and Mergui coasts of Burma. In this connection Government have recently appointed a tan expert from England, who is bringing out an up-to-date plant with which to experiment.

Jute and Cotton Bobbins.

Then, again, a definite start has been made to capture the import trade of jute bobbins, and a factory is now working which turns out a high-class bobbin from Indian timber. A similar inquiry is in progress to manufacture cotton bobbins of all descriptions. Both jute and cotton bobbins are imported in very large quantities into India, so that in both directions there is an excellent opening for further development.

"*Boswellia serrata*" Gum Oleo-Resin.

One of the most common trees in the dry zone forests of India is *Boswellia serrata*. It occurs generally on the hot, dry slopes of the hills of Central India, in the Central Provinces, and the Deccan, and may be called the forerunner and nurse to the more valuable species. The timber is generally valueless, but owing to it being practically the only covering to the soil in many localities, its preservation is of great importance. It, however, yields a valuable gum oleo-resin, which has attracted the attention of the chemist to the Forest Research Institute and others for some years. After a good deal of trouble and patient trials, a simple means has been found by which it is possible to split up this substance into its component parts. Quite recently samples of the rosin have been submitted for valuation to the Imperial Institute, which classed it as equal to "G" grade colophony, while one Calcutta firm has pronounced it excellent for varnish work, and another suitable in the preparation of shellac. Samples of turpentine were submitted to the Imperial Institute, which sent them on to London merchants for their opinion, with the following result: "(1) that the oil is of very good quality and closely resembles American turpentine oil, except as regards the smell, and (2) that *Boswellia* oil could be successfully employed like ordinary turpentine oil in the manufacture of varnishes. All the firms consulted thought that the *Boswellia* oil would be readily saleable in the United Kingdom." Samples of this oil were also submitted to Indian firms, who gave precisely the same reports as those obtained from England.

Samples of gum were submitted to an Indian firm, who state "that it is a substitute for farina, and that it would serve the same purpose for either finishing or sizing calico."

At the same time as the work was being carried out in the laboratory, tapping experiments were carried out in the field to determine the most advantageous method of tapping the trees. A method by which the outer bark is removed with a draw-knife, "freshening" the wound at fixed intervals, was found to give satisfactory results. From these experiments it was ascertained that in a month the following amount of the gum oleo-resin could be collected:—

100	trees of	24 in. to 30 in.	girth, yield	15·08 lb.
100	,, ,,	30 in. to 36 in.	,, ,,	17·76 lb.
100	,, ,,	36 in. and over	,, ,,	20·65 lb.

The tree can only be tapped for five months in the year, so that the average yield from large trees may be taken at 1 lb. per annum.

The number of trees available in one locality only has been roughly estimated at three millions in the Chopda, Yaval, and Raver ranges, and at 200,000 in the Deomogra Reserve of the Khandesh Forest Divisions—namely, in one Collectorate of the Bombay Presidency only. As this species is scattered all over the dry zone of the Peninsula, a rough idea may be obtained of the vast number of trees available.

Other Industries.

It is not possible to deal in detail with the many and varied forest industries which it is hoped may be developed in the near future in India, and about which a considerable amount of information has been collected in recent years. Amongst others may be mentioned the erection of sawmills to deal more effectively with the so-called "inferior or auxiliary species of timber"; the introduction of more up-to-date methods of extracting "cutch" and "kuth" from *Acacia catechu*; the introduction of steam distillation instead of the present direct fire process for the extraction of "rosha" or "palmarosa" oil from *Cymbopogon Martini*, a grass found in Central India, the Central Provinces, and the Deccan; the manufacture of pencils, penholders, and rulers; the manufacture of toys for sale in bazaars and

turnery work in all its branches; the more extensive cultivation of lac and improved methods of preparation; the extraction of "kosum" oil for soapmaking and the preparation of glycerine from the seeds of *Schleichera trijuga;* and the manufacture of tea-boxes, dry goods, packing-cases, and barrels.

There are naturally other forest industries which might be mentioned, but, as little reliable information is as yet available about them, they have not been mentioned in this paper. Any information collected by the Forest Research Institute is at the disposal of interested parties, and can be obtained by a reference to the Forest Economist, Dehra Dun, India.

[Owing to the absence of the author in India the paper was read by MR. LAURENCE MERCER, C.I.E., late President, Imperial Forest Research Institute and College, Dehra Dun.]

(The discussion on the paper will be published next week.)

PEANUT INDUSTRY OF SHANTUNG PROVINCE.

The following condensed translation of a report prepared by the Japanese Military Administration at Tsingtau regarding the exportation of peanuts from Shantung Province has been sent to his Government by the United States Consul at Tsingtau:—

The sowing season for peanuts in Shantung is in May and June, and the harvest season is in October and November; hence the busiest time in the peanut export trade is from October onwards.

It is estimated that the province produces about 500,000,000 lb. of peanuts per annum, and that it exports about 266,000,000 lb. of shelled and unshelled nuts. In 1903 and 1904 the total exportation of peanuts through the port of Tsingtau was about 2,500,000 lb., but by 1912 it exceeded 100,000,000. While this tremendous increase was partly due to the growth of Tsingtau as a port, it was also caused by the discovery of the possible utilisation of peanut oil in manufacturing soap, as a substitute for olive oil, and for culinary purposes, and of the nut itself, after baking, as a substitute for coffee and for mixing with chocolate and cocoa, and as an ingredient in biscuit making. Hitherto some 60 per cent. of the total export has gone to Europe, mainly to Germany and France, and 40 per cent. to Shanghai and Hongkong.

The shipment of peanuts from Tsingtau dwindled to such an extent during the first eight months of 1915 that only about 3,000,000 lb. were exported, of which 234,000 lb. went to South China and the remainder to Japan. All these shipments were made by Chinese dealers, except 226,000 lb. shipped by a Japanese firm. This decrease was caused partly by a diversion of the trade to other ports, due to local complications.

While certain localities are recognised as producing a better grade of nut than others, quality is said to be determined by reference to the shape, the shell, and the size of the kernel. In the better quality the thin interior peel is pinkish; in the inferior it is yellowish.

Peanuts are generally packed in gunny bags. One bag contains 80 lb. of unshelled nuts or 160 lb. of shelled nuts. As shelled nuts are heavier than unshelled, thicker bags are used for packing them, and generally the bags in which shelled nuts are packed are marked with a blue stripe. Freight is charged by weight in the case of shelled nuts and volume in unshelled. In packing, peanuts are classified into "native quality" and "selected quality"; the former consist of 60 per cent. of first and 40 per cent. of second quality nuts, and the latter wholly of better-grade nuts. Peanuts are often shelled by hand in the interior during the winter months, labour under these circumstances costing about 3*d.* a day.

Peanut oil is considered a staple product of the Province of Shantung, and is said to be exported through Tsingtau to the extent of about 40,000,000 lb. annually. The nuts are ground in the interior and the oil is brought to the port in waterproofed baskets containing 160 lb. each. Its value locally is 2¼*d.* to 3*d.* per pound. It is shipped mainly to Shanghai, Canton and Hong-Kong, where a portion of it is repacked in kerosene tins, and sent abroad. This trade locally is almost entirely in the hands of Chinese. Peanut-cake (pressed refuse after making oil) is used mainly for feeding domestic animals, and costs locally about 1*d.* per pound.

INDIAN OPIUM.

The *Colonial Journal* draws attention to the use of Indian opium for medicinal purposes in this country. Morphine and codeine, the two principal alkaloids of opium, are largely used in medicine, and are specially valuable in war-time. The opium used in their preparation was imported before the war from Turkey and Persia. The first of these sources of supply is now cut off, while the other is difficult of access. Recourse was therefore had to India (which country formerly exported its opium to China), and the Indian Government gave special permission for the shipment of Indian opium to the United Kingdom. As at present produced, Indian opium is not so consistently rich in morphine as Turkish and Persian, but the impression (which has recently received considerable publicity) that it is not suitable for European medicinal purposes requires immediate correction. As a matter of fact, Indian opium is already being freely used by morphine manufacturers in the United Kingdom.

An exhaustive investigation into the qualities of Indian opium has been in progress for some years at the Imperial Institute, and in an article pub-

lished in the *Bulletin* in 1915 it was shown that, out of 102 samples of Indian opium collected in 1909, only thirty were unsuitable for medicinal use in the United Kingdom owing to a deficiency in morphine. At the suggestion of the Imperial Institute, experiments are now being conducted in India as to the comparative merits of different varieties of poppy for opium production, and there seems no reason why in course of time an Indian product equal to the Turkish should not be forthcoming. The quality of Indian opium can, however, be considerably enhanced at once by improving the present methods employed for its collection and preparation.

FLAX-GROWING IN EGYPT.

A series of experiments with the object of determining the best methods of growing flax in Egypt are being carried out in one of the Government farms under the direction of Mr. S. C. Dudgeon, the Consulting Agriculturist to the Ministry of Agriculture. His report on the first year's results has recently been issued, and is summarised in the *Pioneer Mail.*

He points out that the area under flax doubled in 1915-16 as a result of the activities of an association of growers interested in the provision of the fibre for the French markets, and thinks it highly probable that this year a further extension will take place, though even then the resultant crop will be infinitesimal compared with the requirements in Europe, which are still unsatisfied. The Government experiment was carried out with Egyptian seed, and gave an average yield per feddan (1,038 acres) of retted stalks of 29·56 cantars (1 cantar = 100 lb.), and of seed 5·63 ardebs (1 ardeb = 5,444 bushels), making a gross return of £E34,063 per feddan. Mr. Dudgeon considers that this is an indication of the very satisfactory results which can be obtained at the present time with respect to this crop, which only occupies the ground for four and a half months, and adds that experiments are now being carried out with seed of new kinds imported from Ireland and India, the latter with a special view to obtain better yields of linseed. These experiments will also doubtless show whether the deleterious effect of flax-growing upon the soil, which is complained of in some of the northern countries, is also felt in Egypt. Local habitual flax-growers maintain that there is no deterioration, and Mr. Dudgeon considers it quite possible that upon the rich soils of Egypt a crop of flax does not exert such a severe influence as would be experienced in the case of less fertile land. If this can be satisfactorily proved, and the gross return per feddan can be shown to be consistently that produced in the experiment conducted last year, then the great objections to flax-growing in Egypt would appear to have been overcome, and a profitable by-product (to cotton) will have been given to the country.

CANADIAN SALMON.

There are several varieties of salmon in Canadian waters. The Atlantic salmon (*Salmo salar*) is found in the Maritime Provinces and Quebec along the Atlantic and Gulf coasts, and the rivers emptying into the sea. It is famous for its excellent flavour. In some of the lakes of New Brunswick, according to "Canada, the Country of the Twentieth Century," there is a land-locked salmon differing little from the Atlantic salmon, and certain lakes of Quebec have a salmon of remarkably fine flavour known as the Onananiche. The catch of salmon in 1914 was 1,798,500 lb. in New Brunswick, 1,276,100 lb. in Quebec, 940,100 lb. in Nova Scotia, and 9,000 lb. in Prince Edward Island. Nearly the whole catch of salmon in these eastern provinces is used fresh, although small quantities are smoked and dry-salted. The Canadian salmon-canning industry is located in British Columbia, the quantity canned during the fiscal year 1914 being 1,400,252 cases. In addition to the quantity canned, 11,830,000 lb. of British Columbia salmon were used fresh, 12,344,500 lb. dry-salted, 2,520,200 lb. mild cured, and 1,352,500 lb. smoked. The salmon coming from the sea run up all the rivers of British Columbia to spawn, but the greatest runs are on the Fraser River.

The most important salmon of British Columbia, from the commercial point of view, is the Sockeye or Blueback. It is used most extensively in the British Columbia canneries, as its flesh is not only of fine flavour, but contains a large amount of oil. Other varieties canned are the Coho or Silver salmon, the Quinnat or Spring salmon, and the Humpback or Pink salmon. The Quinnat, which is the first to ascend the rivers, is the largest of the Pacific coast salmon, and is in great demand as a fresh fish. It is most plentiful in the waters around Queen Charlotte Islands and the vicinity of the Skeena River. The Dog or Chum salmon is not regarded as very suitable for canning, but is excellent when fresh or salted, and large quantities of salted Dog salmon are consumed in Japan. British Columbia has 81 salmon canneries.

In the Yukon territory 182,000 lb. of salmon were caught and used fresh in 1914.

THE LYONS (INTERNATIONAL) FAIR, 1917.

The following particulars relating to the Lyons Fair, supplied by H.M. Consul-General at Lyons, are published in the *Board of Trade Journal*:—

There were nearly three times as many stands this year as last, and about twice as many exhibitors. The bulk of the exhibits were housed in wooden booths along the wide quays of the Rhone, on the river side, but a new feature this year was the long row of permanent concrete buildings in which most of the metallurgical exhibits were shown. A certain number of exhibits were also housed in municipal buildings.

Switzerland had by far the largest representation

of any foreign country, and the Swiss stands, showing mainly machinery and electrical appliances of various kinds, enjoyed a considerable measure of success.

The Italian goods shown covered a wide range—china and glass (including an important exhibit of medical glass), lace and embroideries, art printing, fancy leather goods, leather and hides, various tissues, hosiery, sculptures, and toys.

Amongst the British exhibits the Colonial produce displayed at the stand of the Permanent Exhibition Committee of Trinidad attracted considerable attention and numerous inquiries from would-be buyers.

The United States exhibits consisted almost entirely of machinery and motor-cars, but a novel feature was to be found in the stand rented by the United States Consulate at Lyons, at which a number of catalogues of United States firms were on view, with, it is understood, satisfactory results.

The French exhibits covered an immense range, scarcely a single French industry being unrepresented. An important exhibit was that of the fur trade. The Colonial stands were also of interest, while the Lyons silk industry was adequately represented.

From inquiries in various quarters, it is believed that, though business in the aggregate was below the level of 1916, the majority of the exhibitors have done well—many of them better than they expected. With three times as many sellers and fewer buyers, the total volume of business actually done will, it is thought, prove to be proportionately below the 1916 figure, which was estimated at some £2,000,000. The British firms exhibiting seem on the whole to have done well.

RAMIE.

A new method of preparing ramie has been proposed, viz., by retting based on bacterial action, and it is claimed, according to the *Colonial Journal*, that it has a great future. The International Institute of Agriculture states that retting takes forty-eight to sixty hours, and is a perfect success both on the stalks and the strips and the derived product called "China-grass." The well-known difficulties, however, experienced in getting rid of the cork-like film will hardly allow of applying it except to China-grass. Energetic washing is needed after retting. The resulting fibre, however, differs from the ramie fibre obtained by chemical retting. It differs greatly from silk waste, which the last-named resembles; on the other hand, it very much resembles the superfine qualities of flax.

The product obtained is stronger, the fibres are more parallel, and it is easier to obtain long yarns with high yield. It is also possible to carry out bleaching, at least in medium sizes, on the finished yarn, and even to disregard this operation in inferior products and all those which do not need it owing to their purpose. The cost of retting may be estimated at 1s. 8*d*. per cwt. of China-grass in normal times, and the combing yield may go up to 44 per cent. This method will render ramie-growing possible in very many districts, when advances in machinery have furnished the means of producing China-grass by mechanical means.

ERASMUS DARWIN'S PREDICTIONS IN TECHNICS.

Erasmus Darwin, in the text and notes of his "Botanic Garden," first published in 1791, predicts several, or indeed many, subsequent fundamentally important advances in technics, the predictions being so remarkable and in some cases so detailed as to deserve more than a mere passing attention at the present time.

Darwin had reached the age of sixty when the "Botanic Garden" was issued (1791), and other works followed in quick succession, among which may be mentioned "Zoonomia" (Vol. I., in 1794), "Phytologia" (1800), and "The Temple of Nature, or the Origin of Society," which appeared in 1803, about a year after the death of the author, whose last few months appear to have been devoted to the elaboration of the notes and "Additional Notes" of this his final work—a work almost unread and unnoticed in our time, though deeply interesting from the technical standpoint, but especially interesting as embodying developments and perfectings of the author's view that all living organisms originate in a living filament subject to the conditions of its environment, and affected by heredity and response to pleasure or pain.

The life of sixty years' duration which preceded the publication of "The Botanic Garden" was, to a considerable extent, passed in company with the intellectual giants of the period, kindred spirits that constituted the Lunar Club, or Lunar Society, the membership of which included Dr. Priestley, Benjamin Franklin, W. Herschel, Dr. Black, James Watt, Matthew Boulton, Samuel Johnson, Josiah Wedgwood, and Samuel Galton. It may not be unreasonable to assume that the numerous technical notes and suggestions contained in the "Botanic Garden" and other writings of Erasmus Darwin were to a considerable degree the outcome of discussions at the meetings of the Lunar Club, or Lunar Society.

"The Botanic Garden" of Darwin includes, as Goethe puts it in a letter to Schiller (dated January 26th, 1798), a minimum of botany with a plenitude of discursive technics and other matters, which Goethe summarises in an account which fills some three pages (Vol. II., pp. 27–31) of the recently published correspondence between Schiller and Goethe (Jena, Diederichs, 1905).

The dicta of Darwin as to the future of steam power are of especial interest now that his pre-

dictions as to flying-machines have been so remarkably realised. The passage beginning

"Soon shall thy arm, unconquer'd Steam,"

is now a "familiar quotation."

The technical reader does not require a reminder that the internal-combustion engine of modern times is essentially a steam engine, and it would be wholly a steam engine were the fuel only hydrogen and oxygen—a technical possibility now that these gases can so readily be produced on a large scale by the electrolysis of acidified water. If, on the other hand, the internal-combustion engine be actuated only by a non-hydrogenous fuel such as carbon monoxide, the element of steam is eliminated, or rather would be if adventitious water were absent. When, however, the fuel is a hydrocarbon of the C_nH_{n2+2} series, steam is the predominating factor.

If any one were to care to argue that the internal-combustion engine ought not to be regarded as a steam engine, it would be sufficient to point out that Darwin evidently intended his remarks to apply to the internal-combustion engine. In a footnote on page 16 of the 1825 reprint edition he says: ". . . there seems no probable method of flying conveniently but by the power of steam, or some other explosive material, which another half century may probably discover." Another note on the same page deals with the quantitative kinetics of gunpowder, and he foreshadows a chlorate gunpowder "from aerated marine acid," also a nitrous acid preparation which ". . . may probably in time be applied to move machinery."

In another place (pages 82 and 83) Darwin gives a long and detailed history of the steam engine, in the course of which he refers to experiments made by Papin. Although in Dr. Darwin's notes I find no mention of the Colbert or Colbert-Papin rudimentary internal-combustion engine, which is described by Papin in the "Acta Eruditorum" (September, 1688), it may be taken for granted that Darwin knew of this, as it is impossible to suppose that such "Lunars" as Black, Watt, and Boulton would have failed to discuss the matter at the monthly meetings, which were held at full moon time so that long-distance travelling by road might be facilitated. The individual "Lunars" frequently refer to the "Acta Eruditorum," and probably several of them owned the set of 117 volumes. It may be mentioned that the Colbert-Papin engine—if, indeed, one may call the rudimentary form as indicated in the "Acta" of 1688 an engine—was really an atmospheric engine like the Newcomen engine or the Otto-Langen gas engine. Papin shows how an explosion of gunpowder can lift the piston, and that the atmospheric pressure can force the piston down.

The modern submarine and its uses are very definitely foreshadowed in the well-known passage beginning—

"Lo! Britain's sons shall guide
Huge sea-balloons beneath the tossing tide."

There is much more both in text and notes, and note may be made of the reference to the possibility of reaching the Pole by the way of the warmer water under the ice. The references given by Darwin to some of the early submarine experiments may be supplemented by mention of the "Acta Eruditorum." In the issue of February, 1683, the eminent Italian mathematician, J. A. Borelli, describes and figures a scheme for a submarine boat, and in the same communication Borelli suggests and figures a scheme for a mobile diver. Both suggestions are crude, but the suggestion for the mobile or independent diver may be worth consideration from the point of view of a diver so equipped as to carry his own motor and carry his own air supply—a device having the same kind of relation to the submarine ship that the motor cycle has to the motor car.

Much more might be said as to Darwin's technics and his multitude of suggestions, or as to the desirability of new annotated editions; but the feeling of the present day rather favours experimental research than a study of the older publications or historical research.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Raw Material.—The value of the raw textile materials entering the kingdom in the months January-April exceeds that of the same period in 1915 by some 7 per cent. It is instructive to turn from this fact to the particulars of quantities, which show that the volume of raw cotton, flax, hemp and jute was almost precisely half that of two years ago, while imports of sheep's wool and silk were 60 per cent. There may well, therefore, be a widespread complaint of the shortage of raw material and a general disposition to extend the Whitsun recess. Upon present appearances, there is no escape from the necessity for shortening hours and reducing production, and, indeed, the Government has imposed a curtailment of one day a week upon the wool-consuming industries. It is unfortunate that this new development should coincide closely in point of time with renewed demands for the substantial increase of wages, and in one way and another an undisguisably awkward time lies ahead.

War Clothes.—Successive manœuvres have brought the Government into virtually sole possession of the wool supplies, and the intention has been declared of accumulating a considerable reserve of that material. The desirability of so doing can be inferred from the calculation that 32 lb. of wool are required to equip a

single soldier. The reference is presumably to wool in its greasy or unscoured state and, by erring rather on the side of understatement, the amount of clean scoured wool can be taken at 17 lb. The process implies that the equipped soldier consumes seven times the quantity normally available year by year for each unit of the population of Europe and North America. The supply is in effect being reserved for the Allied Forces, a carefully measured allowance going for the purposes of civil export trade. The home population is seemingly doomed to live off the hoard that cloth traders have accumulated, and as the quantity is computed at enough for twelve months, no particular alarm is occasioned. If more is required in the interests of decency or to forbid an excessive range of prices, it is proposed to sanction the manufacture of definite quantities of certain standard goods. Wool is a material which can, at a pinch, be diluted even more readily than flour, and the setting up of standard qualities does not want for sound defences. There are descriptions of wool which can naturally be best spared for secondary purposes, and use should be made preferably of these. By reducing quality to a standard, it will be simple to standardise prices and profits, and no reason exists why the standard goods should not be made in a pleasurable variety of patterns and colourings.

The Textile Institute.—The return of happier times should enable the Textile Institute to resume its concern with the domestic problems of the industry. Reasons not difficult to appreciate have seemed to convert that forum into one for the discussion of sufficiently important questions of the neglect of science and the defects of the educational system. There are other institutions in which these public questions are aired, but the institute is unique in its obligations to textile industry. Measures already afoot aim at placing this organisation in a position to render greater direct service, and to provide it with experimental and statistical departments, a library, and a commodious meeting hall. Sir William Mather has asked for a fund of £25,000—an amount not at all too large for the 5,000 Lancashire textile firms to subscribe, even were there no contributions from people at some distance from Manchester. Sir William Mather has no need to extenuate the occupancy of the presidential chair by an engineer. The kindred of engineers and manufacturers is thoroughly acknowledged, and it is closer alike in habit of mind and by association than with the chemists or even the textile teachers, whose voices too often strike the ear as remote.

Some Possibilities.—A powerful reason for the closer alliance of textile industry with chemistry was suggested in Sir W. Mather's mild inquiry as to who could say what would be the chief fibre used in Lancashire or Yorkshire in less than a hundred years hence. A century ago there may well have been doubts in Lancashire of whether the future lay with silk, cotton, or the ancient woollen. Yorkshire was then only receiving the first two or three packages of the Australian wool upon which its industry now lives, and it is probable that nobody except the chronic pessimists actually thought the wool industry would be cleared out of East Anglia. The changes of the future might be as violent as those of the past without being of precisely the same order, and the change we have the best right to expect is such as may be wrought by chemists working upon the body of the fibres now used and known, or upon other materials for the production of artificial fibres. With the past of Norwich and Coventry before our eyes, it is difficult to feel certain that the present centres of textile industry will inevitably be those of one hundred years hence. The war already promises radical changes in such fundamentals as costs of power, labour and inland transport, and there is no saying to what cheap electricity, water carriage, and the development of new areas might lead if accompanied by a neglect of science comparable with last century's neglect of mechanical inventiveness in the deserted districts.

Berlin Wool.—An intelligible sentiment underlies a drapery trade resolution in favour of discontinuing the use of the name "Berlin wool" to distinguish the kind of knitting yarn commonly so called. The protest compares strictly with that raised a while ago in other quarters against the description "German silver." The term has at least acquired a certain handiness as a description for a particular 4-ply or 8-ply knitting yarn of a distinctive softness, dyed in brilliant colours, and no alternative name for it has commanded universal understanding up to the present. Berlin wool of excellent quality is manufactured in England as well as in Germany, by some who make also "Scotch fingering" wool. The name does apparently derive from an original German supply, which is more than can be affirmed with any certainty of some other geographical textile terms. Where, for instance, is the link with Italy in the goods called "Italian linings"? The less known "Spanish stripes" get their name seemingly from their suitability for the Spanish markets, or from their resemblance to similar scarlet goods sent in centuries past from Spain. "French merinos" are French to the extent that the threads are arranged in the same manner as certain French ones were and doubtless are. There is some reason to believe that "worsted," standing now for a whole system of preparation of wool, won its

first fame as nothing more than the particular alternation of threads adopted by the small colony of weavers in Worstead, Norfolk—an order distinct from that favoured in some adjacent villages of no less industrial consequence in their day. The cotton "Irishes" that Manchester sends to China are by no means of an inevitably Irish make in these days, and in point of fact the property in place names can with difficulty be kept in these times by fighting for it. There may be some consolation in the idea that the name Berlin wool upon a thoroughly British article gives a virulent grievance to patriots in Germany.

Army Goods.—People who are making cloth to the admiration of our own and other armies will set down as apocryphal the startling story told to a House of Commons Committee by Mr. Randle Jackson in 1806. It concerns a Russian brigade newly clothed with English cloth happening to be exposed to a drenching storm. The coats of the brigade shrank into waistcoats, and his audience was asked to believe that "one of the Yorkshire masters, a respectable magistrate," had admitted the truth of the anecdote. Rubbishy army cloths were shipped both before and after the period named; but there is no cause to fear such a condemnation as was made in 1593 by the Captain of the Forces of the Low Countries. He found "the apparel not equal to the patterns . . . bad stuff which soon wears. The cloth shrinks, the stockings are short and the shoes bad," continued this plainspoken critic. Complaints may be heard from the front of the inadequacy of supplies of new or clean clothing, but the quality of the stuff sent has been a revelation that will affect the choice of cloths in after-life. There are soldiers who want to buy for themselves just such fabrics as the Government has issued to them.

CORRESPONDENCE.

COTTON-GROWING IN QUEENSLAND.

A recent press cable stated that cotton-growing in Queensland and other parts of the Empire was to be considered at the time of the Imperial Conference. The position seems to be :—

1. That cotton can be grown most successfully, even during our dry spells, if it gets rain to start it.
2. That growers could afford to pay even ¾*d.* per pound for picking if assured that pickers would be available in sufficient numbers.
3. That a novice does not pick many pounds his first day, and if there are no expert pickers in his district to show what can be done by picking correctly he will probably give up.
4. That there are probably not twelve men in Australia who have picked 300 lb. of cotton in one day, but there would be more in every small American cotton-picking community. Australians should be taught how to pick.
5. That cotton picking is light work, but the sharp, hard bracts around the cotton worry the novice if he hastens.
6. That field tests of, say, fifty acres each in three districts, with four expert pickers and some Australian novices, would probably introduce the industry.
7. That as mechanical pickers would be far more advantageous in Australia than in America, where trained pickers are abundant, a further area should be planted and picked by mechanical means.
8. That if the first experiment ended as we would anticipate, a huge experiment, with, perhaps, a thousand farmers' sons, should be warranted for the following year.
9. That cotton grows so unusually well with us that we should be able, each year, to produce cotton to the value of the annual interest of our War Loans; but it would need an army of workers, as practically all the expenses are for labour and not for plant.
10. That the probable prize is so great that the nomination fee—for preliminary experiments—is worth paying.

G. Stephen Hart,
Hon. Sec., Munitions Cotton League.

The Munitions Cotton League,
Mount Morgan, Queensland, Australia.
March 17th, 1917.

NOTES ON BOOKS.

Aircraft of To-day. By Charles C. Turner. London: Seeley, Service & Co. 1917. 5s. net.

In the year 1816 the Secretary to the Admiralty wrote to Sir Francis Ronalds "that telegraphs of any kind are wholly unnecessary, and that no other than the one now in use [the semaphore arrangement] would be adopted." In the year 1907, Mr. Turner tells us, the Secretary for War wrote to the brothers Wright that "the War Office is not disposed to enter into relations at present with any manufacturer of aeroplanes."

It is therefore clear that the progress made by scientific discovery during the nineteenth century has by no means been without its influence on the British official. He has learned to be less dogmatic and more diplomatic. He did not say that "aeroplanes were wholly unnecessary," and that nothing but kites or balloons would be adopted. He declined to discuss the matter at all, and "smiling put the question by."

Meantime the war has hurried matters up a bit, and the War Office has not only entered into relations with the manufacturers of aeroplanes, but has entered—very successfully—on the manufacture itself.

The public are hungry for such information as can reasonably be given them about

those wonderful machines which, during the ten years since the brothers Wright were politely snubbed by the War Office, have done so much to change the character of modern warfare. Such information as can be provided without injury to the interests of the country will be found in Mr. Charles Turner's book. Eight years ago, five years before the war, he gave the Society an excellent course of Cantor Lectures on "The Romance of Aeronautics," and he has since been steadily working at the subject, and has published much valuable information upon it.

After some historical chapters, the author proceeds to discuss the principles of mechanical flight in airships and aeroplanes, the general difficulties of aerial navigation, the qualifications and training of the aeronaut, the development of the modern aeroplane, and kindred subjects. Finally, he gives us some chapters on the use of aircraft in war, on land and at sea. The book is essentially a popular one; it is not a handbook on flying, and though it will be read with interest by experts, it is intended not for them, but for the numerous public who have neither scientific knowledge nor practical experience, yet are anxious for accurate and simple information on a subject in which we are all interested, although most of us really know very little about it.

Seeding and Planting. By James W. Toumey, M.S., M.A. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 16*s*. 6*d*. net.

The figures relating to forestry in the United States are on a huge scale. It is estimated that at the time of the settlement of the country the forest regions covered an area of about 850,000,000 acres. By fire, lumbering and clearing this figure has been greatly reduced, but the forest area is still estimated at 550,000,000 acres, or 29 per cent. of the total area of the country. Of this the publicly-owned forests contain more than 100,000,000 acres of merchantable timber, while the privately-owned forests contain approximately four-fifths of the merchantable standing timber.

Vast as these figures are, at the present time every large source of timber supply in the United States is being drawn upon to meet the demands of the home markets; and the necessity for organising and managing the forests of the United States (in which direction up to the close of the last century but little had been done) is becoming urgent. And apart from their direct importance as sources of timber supply, forests have an indirect value which must not be lost sight of. "The destruction of our forests, if carried too far," writes Mr. Toumey, "will . . . affect the general happiness of the entire nation. Our general health, both moral and physical, will suffer and our future prosperity will be jeopardised. Although we cannot measure the indirect value of the forest by money value, the history of China, Greece, Asia Minor, and many others of the older nations clearly shows its importance. The effect of the forest upon soil conservation and fertility and upon stream flow and erosion are beyond conservative estimate."

If the subject of forestry has not received the attention which it deserved in the past, there are many signs that the authorities in different countries are now alive to its importance. In Great Britain, for instance, schools of forestry are attached to several of the universities, so that it is no longer necessary (as was the case not very many years ago) for British students who wished to study forestry to go to Germany for their instruction; and recent papers read before the Royal Society of Arts (including one published in this issue of the *Journal*) show what is being achieved in this direction by the Government of India. In the United States the University of Yale (amongst others) has a Forest School, of which Mr. Toumey is Director, and he has written this book to serve as a manual for the guidance of forestry students, foresters, nurserymen, forest owners and farmers. In the first part he discusses the silvical basis for seeding and planting, under which he includes the choice of seeds in artificial regeneration, the principles which determine spacing, and the principles which govern the composition of the stand. Part II. deals with the artificial formation of woods, and includes chapters on forest-tree seed and seed collecting, the protection of seeding and planting sites, the forest nursery, and the establishment of forests by planting.

It is obvious that the problems of forestry must vary greatly according to the altitude and the climate in which the forester's work lies; but certain general principles may be laid down which are applicable to the science as a whole. These are stated in a lucid and readable form by Mr. Toumey, whose work should prove a valuable text-book to those for whose use it is intended.

GENERAL NOTES.

National Committee for Relief in Belgium. —In view of the fact that the United States Government has generously assumed all financial responsibility for the work of the Commission for Relief in Belgium, the National Committee for Relief in Belgium has decided to suspend its appeals to the public in the British Empire. Any monies received after June 1st will be held to provide for emergencies now unforeseen in connection with relief in Belgium. This course of action is in accordance with the suggestion made by Mr. Hoover, Chairman of the Relief Commission, who is now in Washington, and has the approval of His Majesty's Government and the Belgian Minister. During the existence of the Committee over £2,400,000, subscribed throughout the British Empire for the relief of our oppressed Allies in Belgium, has passed through its hands.

Illuminating Engineering Society. — The seventh annual Report of the Illuminating Engineering Society was presented at the annual meeting on the 15th inst., which was held in the Room of the Royal Society of Arts. The society, dealing with the scientific and industrial aspects of a wide subject, unites on common ground gas engineers, electrical engineers, manufacturers of lamps and shades, physicists, ophthalmic specialists, architects, and surveyors. This branch of engineering has been recognised by the appointment, under the Department of Scientific and Industrial Research, of a Joint Committee on Illuminating Engineering, which is carrying out some valuable experimental work for the Government. The successful union of these various interests is largely due to the efforts of the Hon. Secretary, Mr. Leon Gaster, during the last ten years. Mr. Gaster is a naturalised British subject of Rumanian origin. All the male members of his family who are of military age are fighting for the Allies, and one of his nephews was recently killed in Rumania.

Japanese-Australian Trade.—Japan appears to be rapidly capturing the toy-markets of Australia, which were formerly monopolised by Germany. Whereas Australia purchased only £3,000 worth of toys from Japan in the first five months of 1914, the figure rose to £25,300 for the corresponding months of 1916. Taking the same periods of these two years respectively, Australia bought £12,000 worth of Japanese cotton tissues in 1914, as compared with £53,000 worth in 1916; and £3,500 worth of porcelain in 1914, as compared with £52,000 in 1916.

Acetone.—Until recently our supplies of acetone, of which enormous quantities are now required in the manufacture of propellants, have been largely obtained from foreign countries, where cheap supplies of waste wood were available for destructive distillation for acetone production. Since the outbreak of war, however, says *Engineering*, this position has been radically altered, and acetone is now produced in this country on a large scale by the distillation of wood and in other ways. The question is also being taken up in other countries of the Empire—it is proposed, *e.g.*, to erect a factory for this purpose in Natal, where wattle wood will be used as a raw material. The possibility of similarly utilising the wattle wood accumulated in connection with the wattle-bark industry of the East Africa Protectorate is also under consideration, and at the Imperial Institute a series of trial distillations with this wood, and also with olive wood from the same Protectorate, has just been concluded. The results show that the yield of acetone and acetic acid from both woods is satisfactory. A good yield of acetic acid is also being obtained in Ceylon from the distillation of cocoanut shells and various local woods. Attention is also being given to the subject in the State of Mysore, and it seems likely that in a short time the Empire will be able to produce all the acetone and acetic acid it requires.

British Trade.—At a recent meeting of the Advisory Committee to the Board of Trade on commercial intelligence, it was stated that at the British Industries Fair, which, owing to war conditions, was necessarily restricted to the toy, fancy goods, pottery, glass, printing and stationery trades, the number of exhibitors was 444, as compared with 350 in 1916, and the number of visitors 15,000, as compared with 13,000 last year. It was also reported that over 700 firms had applied for interviews with H.M. Trade Commissioner for Canada, who is now in the United Kingdom on an official visit.

SIR ARTHUR PEARSON ON "THE BLIND SUFFERERS FROM THE WAR."

It was stated in a footnote, on page 474 of the *Journal* of May 18th, that Sir Arthur Pearson's address on "The Blind Sufferers from the War, and their Future Employment" was delivered *ex tempore*, and taken down in shorthand, and that time did not permit of any revision by the speaker. Sir Arthur has now sent some corrections and verbal improvements, of which the most important are as follows:—

On page 475, column 2, line 14, read: "We do not find it a good plan to keep men at it [Braille] too long, and therefore netting has been introduced into the Braille room as a convenient relaxation."

On page 475, column 2, line 48, read: "That typewriting lessons given at St. Dunstan's are appreciated is borne out by the fact that I daily receive something like thirty or forty letters from men who have left, in almost every case typed as perfectly as the secretary of any business man in this room would have typed them."

On page 476, column 1, last line at foot, read: "Next to the class-rooms come the rooms in which is given preliminary instruction in massage."

On page 480, column 1, line 16, etc., read: "The men work two and a half hours in the morning, and two hours in the afternoon"; and in line 23, etc., read: "But as a general rule 95 per cent. of the men at St. Dunstan's do not work more than two and a half hours in the morning and two hours in the afternoon."

On page 480, column 2, line 34, read: "At the opening of the Albert Hall Bazaar a hundred men from St. Dunstan's sang the third verse of 'God Save the King' after Madame Clara Butt."

On page 481, column 1, line 42, read: "The blind workshop teachers at St. Dunstan's—the boot-makers, basket-makers, mat-makers, every one of them—are fully skilled competent workmen, able to earn their £2 a week."

On page 482, column 1, line 5, read: "We hear the merry laughter of the fellows running down to the lake in their sweaters and shorts to go out for a row."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Report of the Discussion on the paper on—

THE RECENT INDUSTRIAL AND ECONOMIC DEVELOPMENT OF INDIAN FOREST PRODUCTS.

By R. S. Pearson, F.L.S., of the Indian Forest Service,

Forest Economist at the Forest Research Institute, Dehra Dun, India.

(*Continued from p.* 493 *of the "Journal" of May 25th,* 1917.)

The Chairman (Sir Robert W. Carlyle, K.C.S.I., C.I.E.), in opening the discussion, said that he had special pleasure in presiding, because for over seven years he was in close touch with the Forest Research Institute, first of all as Secretary, Department of Revenue and Agriculture, and afterwards as a Member of Council. In those posts he saw a great deal of the work which was being done by the Institute, and he was able to appreciate the excellent services of Mr. Pearson as Forest Economist. The question of the development of the forests in India was of the greatest importance. It was well known how poor the Government of India is, and the great necessity that existed for larger expenditure in many directions—for instance, in the provision of better education, agriculture, industries, and means of communication. In the past the Finance Department had perhaps been too much devoted merely to stopping expenditure, and the savings effected had in some cases the result of stopping proper industries which would have amply repaid the expenditure in a very short time. Outside the Agricultural Department he could see nothing in India comparable to forests as a potential source of revenue. The forests of India consisted of an estate covering an area exceeding Spain, Portugal and Belgium, and at the present time, notwithstanding the labours of the splendid Forest Service, a gross revenue of under £2,000,000 and a net revenue of £1,000,000 per annum was obtained from them; in other words, a little over 3*d*. an acre of gross revenue. He did not believe that at present prices the forests of India would ever produce anything like the revenue derived from equal areas in Germany, but he thought there was a possibility of a development in the Indian forests in the future so large that he was afraid to give even an approximate idea of its extent. But that development was quite impossible unless money was spent in three directions. In the first place, it was necessary to have a staff adequate to treat the forests scientifically, the present splendid staff being absurdly inadequate. In the second place, it was necessary to dispose to the greatest advantage of the full out-turn of the forests, and that could only be done by proper scientific management, which meant money, more money, and still more money. Again, the timber could not be disposed of unless there were not only roads, and plenty of them, but the best mechanical means of extracting the timber. He very much doubted whether it was possible to do all that was required within a reasonable period if the present system was continued of providing for capital expenditure entirely out of revenue. No business man would ever dream of developing a large business by starting in a small way, and setting aside year by year a small portion of his revenue towards extending it. He would either invest his own capital, or, if he had not capital, borrow it; and he had never yet been able to see why the Government of India should be in a different position in that respect from the business man. He could not understand why the Government should not borrow capital to open up and develop the forests. The previous suggestions he had made were of no avail, however, unless forest industries existed on the spot close to where the timber was obtained, and there again an expenditure of money was necessary. Fortunately the Governments in India were now beginning to move in that direction, and there was talk of starting experimental factories. He did not think it would be well for the Government to set up as a large manufacturer; manufacture on a large scale would be quite incompatible with the present Indian account rules, but that was a very different matter from starting factories to experiment on a commercial scale with Indian products. Capital in India was very shy, and the capitalist would not put his money into a business until the Government had shown him he could invest it with a reasonable prospect of obtaining a good return. He was afraid

that, from a financial point of view, the doctrines he had expressed were somewhat heretical, but he trusted they would in time prevail.

Mr. R. W. Sindall, F.C.S., said the paper contained an excellent survey of work that had been done, and a valuable indication of good work which had yet to be accomplished, by the Forest Research Institute. At first sight the industries which had been mentioned seemed to have no relation to one another, such, for instance, as the manufacture of matches, the production of paper pulp and timber, rosins, turpentine and the like; but by taking a wider view of the subject it would soon be seen that they were related, and on a commercial scale could be easily co-ordinated. There were three kinds of wood, the first being hard wood, which produced a certain amount of waste, all of which could be utilised for the production of valuable by-products. The second was wood for the making of paper pulp, and saw-mills would, within a short time, be erected in India with a view to utilising the best class of wood for timber and the inferior qualities for wood pulp; while the wood which could not be used for either of those purposes could be utilised by means of distillation for the production of charcoal and wood spirit. The Shan States of Burma had for hundreds of years produced hand-made paper from bamboo, and there were one or two firms in the Northern States who wrote their commercial correspondence on it. There were, however, several factors against the earlier development of the bamboo proposition. Wood was so cheap and abundant before the war that paper-makers had no necessity to seek for other sources of paper-making material; and while firms in Norway and Sweden were tumbling over one another to make contracts at heart-breaking prices it was not likely that the paper-maker would worry himself about his sources of supply. Probably many of them now wished they had done so. In addition, the early experiments in this country in the use of bamboo for paper-making were not very encouraging, owing to the fact that the paper-makers experimented with old sugar-cane baskets, the result being that the quality of the raw material dealt with was never uniform in composition, and the bamboo was condemned almost entirely on that ground. Another factor was that the paper-makers in this country did not care to co-operate with regard to their raw material. The cost of the installation for dealing with bamboo was also a serious problem, the amount of capital required for a plant treating 100 tons of bamboo per week being about £35,000. The industry could not be developed at present for several reasons, the first being the impossibility of obtaining machinery, while the labour and transport difficulties and the restriction of imports were also very serious. Nevertheless, the subject was an urgent one. Something like 50,000,000 or 60,000,000 trees were cut down every year in the various wood-pulp producing countries for the production of the wood pulp required by the world, so that the forests were rapidly being denuded. Fortunately most of those countries now possessed a proper system of forestry, by means of which the forests were allowed to recuperate, so that the natural resources of the country would not be too largely reduced. One advantage possessed by bamboo was that it grew rapidly, and that a very small area, properly cultivated, would keep a large mill going. He thought the development in India should take place along the lines of the production of bamboo half stuff and the possible utilisation of native chemicals, such as soda, lime and salt. In his opinion there was no reason why practically the whole of the chemicals and the materials required should not be produced in the country itself, and India would then be a very large pulp-producing country.

Mr. H. J. Elwes, F.R.S., said that, having visited the forests of India, he had formed a most favourable impression of the work which was being done by the officials of the new Forestry Institute at Dehra Dun, and looked forward with the greatest hope to forestry in India being put in a very different position after the war. He most strongly confirmed the Chairman's statement that the forests and the foresters had been starved, and, having spent many years in attempting to study the numerous intricate technical questions connected with the production of timber and the utilisation of the products, he had come to the conclusion that the best brains in England were only just good enough to put forestry in India and in the other British Dominions into its proper position. By far the best organised Forest Department in the world was that in the United States of America, which was liberally supported and efficiently staffed; and he suggested that their methods should largely be copied by the Indian Department. The possibilities in India were gigantic, but until there was a very much larger number of properly trained men employed, and much greater attractions were offered to a superior class of men to come into the Forest Department, progress would not be made. It was necessary to convince the powers that be in India, more particularly perhaps the Financial Secretary, that for every rupee spent in a businesslike way in endeavouring to discover how best to utilise the enormous number of untouched products in the forests of India an enormous benefit would accrue. He had seen, more particularly in the Himalayas, enormous quantities of timber, bamboo and other products, not only absolutely wasted, but large sums of money spent on destroying them. When he was a tea planter he had seen thousands of trees cut down and wasted which, if they were standing at the present time, would be worth much money; while in the hilly countries in Burma, Chittagong and Bhutan the matter was at present left to the jungle tribes, who every time they desired to grow a crop of rice burned down a fresh piece of forest. Before timber was cut in

the forests of America a highly experienced forest engineer surveyed it and got out exact costs in regard to waterways, light railways, overhead railways or cable lines, and he also made an estimate of how many million feet of timber would be obtained; in fact, he drew up a balance-sheet of the undertaking. So far as he was aware, little of that sort was done in India at present. The Japanese had been in possession of Formosa for only a very few years, but they had already adopted far more up-to-date methods, both from a mechanical and scientific point of view, than those that existed in most parts of India. Nothing had done so much harm to the forestry of India as a too great insistence upon German methods. It was of much greater importance that our young foresters should visit the United States or Japan than spend their time in Germany and France, where the conditions were so different from those that existed in India. He hoped the Government of India would realise before it was too late the necessity of putting the Forest Service of India and the young men who belonged to it on a very much better footing, and would also realise that it was not the leavings of the Civil Service but the pick of the men that were required to do justice to the forests of India.

SIR WILLIAM DUKE, K.C.S.I., K.C.I.E., thought it was essential that in the development of the forests of India the Government should utilise material which had hitherto gone almost entirely to waste, such as bamboo or grass. It was not to be doubted that all the sound timber that could be produced would be beneficially used probably in more advantageous ways than making paper pulp; but, as Mr. Sindall had said, the prospects were good for the making of pulp on a large scale from hill bamboo and possibly some of the giant grasses. Mr. Sindall had referred to the question of whether India was capable of producing the chemicals which would enable the bamboos to be worked up into paper in that country. Hitherto such manufacture of paper as had been carried out in India had been only a qualified success. It had never been able to supply more than about one-third of the Indian demand, the reason being that the chemicals required in the manufacture were an excessive item in the cost of manufacture, as they had to be imported from Europe. The importance of the question would be appreciated when consideration was given to the point of whether the paper pulp produced in India was to be manufactured into paper on the spot or exported as a raw product for manufacture elsewhere. It would be an infinitely greater advantage to India if the paper could be made in the country and an Indian manufacture thereby be greatly expanded. The question would be found to turn very largely on whether the necessary chemicals could be obtained in sufficient quantities in India.

MR. S. CHARLES PHILLIPS shared the disappointment that had been expressed by previous speakers that the authorities in India had not developed the paper-making industry to a greater extent, and thought there was too much of the "wait and see" policy about them. He thought that they had got very little further than they were thirty years ago, when the late Mr. Thomas Routledge went out to India and devoted much of his time and fortune to research work with a view to the utilisation of bamboo for paper-making purposes. He was pleased to hear from the Chairman that that policy was likely to be displaced, and that the Government recognised it was necessary to do something not only in connection with research work but also from the commercial side. It was all very well for experts to go out to India to investigate the resources of the country, but it must be extremely disappointing to them and to all interested in the subject to find that the commercial element was relegated to more or less obscurity, and that with regard to it the authorities were generally quiescent. He contended that there was practically nothing in the whole of the British possessions which could not be made use of, and thus help to some extent to avoid the necessity of trading with enemy countries. The paper trade was passing through a grave crisis, chiefly, of course, because of the war, but partly from the action of Sweden in putting an embargo upon the export of sulphite pulp to this country. Now was the time to make energetic efforts in the direction of supplementing existing raw materials. It would have been a good deal more interesting to the commercial element in this country if further information had been given in the paper with reference to the elephant grass, particularly its yield per ton after treatment. If bamboo was to be utilised for the benefit of the paper trade of this country, it was time somebody made the material adaptable for paper manufacture on a commercial scale.

SIR LOUIS DANE, G.C.I.E., C.S.I., said he was old enough to remember a very experienced Indian forestry officer say that it was wrong to try and make the forests of India pay. He was glad to say, however, it was now beginning to be realised even in India that a duty rested upon the Government to develop its magnificent resources, and that they could not be developed unless money was spent upon them. So far as match-making was concerned, another match timber existed in India in addition to those described in the paper, namely, the river poplar, but difficulty existed in exploiting it in consequence of the uncertainty as to the ownership of the river tracts in which the wood grew. In his opinion the duty rested upon the Government of India first of all to show that an industry could be conducted at a reasonable profit, and that a certain out-turn could be assured, and then, in the case of minor industries, it ought to hand them over to private enterprise, and do everything in its power to make it worth while for the pioneer in any particular industry to take it up. If it was found when a proposed concession

was examined by the Finance Department of the Government of India that the concessionaire made more than 6 per cent., he was told that it was not in the best interests of India. So far as his experience went, no concessionaire would take up any project unless he was certain of 15 per cent., to which he was entitled as a pioneer. If the industries of India were to be developed it was necessary to recognise that the pioneers must be given a chance of making a reasonable and proper profit, and after that the market would settle itself. As a result of his efforts, the rosin and turpentine industries in the Punjab had been established on a commercial basis. So far as the pulp industry was concerned, bamboo and grass would probably be the materials from which the bulk of the pulp in India would be made; but there were in addition enormous areas of most valuable soft woods in the shape of silver fir and spruce in the higher hills, which were eminently adapted for paper-making. He endeavoured to get a firm to take up the business, but difficulty was experienced in obtaining chemicals at a reasonable rate and also in the lack of the requisite power for the mechanical process of conversion. The want of power would in time settle itself, as dams could be built on all the Punjab rivers, which would have the effect of doubling the irrigation capacity of the canals and provide from 120,000 to 150,000 h.p. There was also a range of salt hills in the Punjab, associated with alum and various other chemicals, and if a commercial firm was given an opportunity of making a good thing out of the business in the first instance there was no doubt that a large chemical industry would be started in the Northern Punjab. Opportunities also existed for the extension of the orchards in India, for the growth of dates and olives, and for the making of boxwood combs so largely used by the Sikhs.

MR. G. M. RYAN, F.L.S., late Indian Forest Service, urged the necessity for the preservation of the trees in India from which mhowra seeds were obtained for the making of soap, margarine and candles. A danger existed that there might be a serious diminution in the numbers of that valuable tree, and it was most important that it should be regenerated. It was thought by some people in India that the growth of the tree should not be encouraged because it was a source not only of forest fires but also of intoxicating liquor. The natives burned the area around the tree in order to clear the ground so that the mhowras might easily be collected, and the fires sometimes spread to the forest, but those difficulties might be overcome. The best trees produced about half a ton to a ton, which before the war fetched from 5 to 6 rupees per cwt. in the market, and in a good year the supplies were not available to meet the demand. Most of the seeds unfortunately went to Germany and to the south of France, and he thought special measures should be taken for improving and developing that important source of revenue to the Government of India, and especially that the product should be kept within the Empire. A great effort had been made by Sir Henry Procter to introduce Powellised sleepers into India, a plant having been erected in Bombay to Powellise the sleepers on the spot, but unfortunately it had not received the support from the different Governments in India that it ought to have done. The Government seemed to be afraid to take action, and he thought it was only right that the public spirit of Sir Henry Procter, whose firm had put over £10,000 into the industry, should be recognised.

MR. WILLIAM POWELL referred to an article by himself published some four years ago in the Indian Forest Records (Vol. III. Part II.) on the antiseptic treatment of timber in India with special reference to railway sleepers, in which he commented on some nineteen different methods of preserving timber, including the system introduced by himself and known as "Powellising."

MR. JOHN A. SMEETON thought there was no sound reason why mechanical wood pulp should not be manufactured in India. He controlled, together with the original concessionaire, a concession from the Punjab and Indian Governments to exploit the silver fir and spruce trees in the Kulu and Bashahir districts of the Punjab and it was his intention to fell 20,000 trees a year and float them down the rivers Beas and Sutlej to a point at which he could use 8,000 h.p. taken from a canal, and thus make 18,000 tons of mechanical wood pulp per annum, which he hoped to sell in India, China, and Japan. Whether he would make any chemical pulp remained to be seen. It was also his intention to manufacture paper, concentrating on a newspaper class, and matches. At the present time 2,000,000 tea-box shooks were imported into India every year, and out of the timber which could not be converted into wood pulp he hoped to make a large proportion of these tea-box shooks in India. He would like to know why the author concentrated his attention so much on chemical pulp, in view of the difficulty that had been pointed out by most of the speakers of obtaining the necessary chemicals in India for its manufacture. Certain criticism had been made of the difficulty in getting the Government of India to move, but that had not been his experience. The Governments of the Punjab and India had gone out of their way to make the terms of this concession easy, with the object, not of making a large profit for themselves, but of promoting an industry which would help the development of the resources of the country. Reference had been made to the use of wooden sleepers in India, but he was afraid in course of time they would be displaced by concrete sleepers. A contract for 750,000 concrete sleepers was placed by one of the Indian railways just before the war, and only the war had prevented its

being carried out. He believed it was the intention of the Indian State Railways to put down works for the manufacture of concrete sleepers in India. Germany and America had not been so insular as British manufacturers in the promotion of industries generally; they had concentrated, and that must be the watchword of British manufacturers in the future. The Indian mills had tried to make too many classes of paper; if they would only concentrate and manufacture for a definite market, whether paper or any other article, he felt certain they could hold their own against the world.

Mr. N. N. Wadia moved a hearty vote of thanks to Mr. R. S. Pearson for his paper, and to Mr. Mercer for reading it.

Mr. A. Wynter Roberts, in seconding the motion, inquired whether it was a fact that no official was employed by the very influential firms engaged in the timber industry in Upper Burma unless he had received a university education.

The resolution of thanks was then put and carried unanimously.

Mr. Laurence Mercer, in reply, having, on behalf of Mr. Pearson and himself, thanked the meeting for the very kind manner in which the motion had been moved, seconded and received, said he thought the truest word in the discussion was that used by the Chairman, that the development of the forest industries of India had been much retarded from want of money. Twenty years ago he remembered hearing the statement made that the Forestry Department was being starved for want of men and money. There was no industry in India that was more handicapped by the high cost of chemicals and the difficulties of transport than the various forest industries, and until those difficulties were overcome the development which they had a right to expect would not be seen. Personally he was not particularly hopeful about the development of the mechanical wood-pulp industry, owing to the cost of transport, and he thought it would probably be found that the cost of the transport to the factory site would be high. There was, in his opinion, more scope for chemical pulps made out of grass and bamboos. There was also probably more scope for the making of tea boxes than for the making of mechanical pulp, unless this latter could be made cheaply. In reply to Mr. Wynter Roberts's question, he had been given to understand that the Bombay-Burma Company prided itself on having high-class men connected with the Company, and thought they were better able to attain their wishes in that respect by employing only university men. Whether that was so or not he could not say, but thought it likely.

Mr. J. S. Gamble, C.I.E., M.A., F.R.S., writes:—I have read through the proof so kindly sent me with much interest, and I sincerely hope that the paper and discussion will have the effect of encouraging the better utilisation of the enormous number of valuable products which the Indian forests are capable of yielding. It is very satisfactory to know that the Indian Government are at last awake to the importance of that utilisation, and especially to the need of making India, as far as possible, independent of imports of articles which the country can itself produce.

Lord Northcliffe writes:—The paper-making resources of India are very well known. But the cheapest material in the world is the spruce tree, especially when it is growing by a river directly connected with the mill, thus eliminating the cost of carriage. I have been into the question of paper-making in India on the spot, and for what is known as "news print" it is not possible for India to compete. In other classes of paper-making the industry could be greatly developed.

NICKEL IN ONTARIO.

In September, 1915, a Commission was appointed by the Government of Ontario to investigate the resources, industries and capacities of Ontario in connection with nickel and its ores. The Commission has now presented its report. It is not yet published, but by the courtesy of Lieut.-Colonel Richard Reid, Agent-General for Ontario, the *Journal* has been supplied with an advance copy of the official summary, from which the following particulars are taken.

After references to the various countries which they visited, including the United States, Great Britain, France, Norway, Cuba, Australia and New Caledonia, the Commissioners say:—

"The two questions that have been uppermost in the numerous discussions that have taken place concerning Ontario's nickel industry during the last twenty-five years are: (1) Can nickel be economically refined in Ontario? and (2) Are the nickel deposits of Ontario of such a character that this Province can compete successfully as a nickel producer with any other country? It will be seen that the Commissioners have no hesitation in answering both of these questions in the affirmative."

The Commissioners then proceed to make the following statements:—

"(1) The nickel ore deposits of Ontario are much more extensive and offer better facilities for the production of nickel at a low cost than do those of any other country. Nickel-bearing ores occur in many parts of the world, but the great extent of the deposits in this Province,

their richness and uniformity in metal contents, and the success of the industry, point strongly to the conclusion that Ontario nickel has little to fear from competition.

"(2) Any of the processes now in use for refining nickel could be successfully worked in Ontario, and conditions and facilities are at least as good in this Province as in any other part of Canada.

"(3) In view of the fact that practically no chemicals are required, that there is a much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the most satisfactory method of refining in Ontario will be the electrolytic.

"(4) The refining of nickel in Ontario will not only benefit the nickel industry, but will promote the welfare of existing branches of the chemical and metallurgical industries, and lead to the introduction of others.

"(5) The methods employed at the Ontario plants, and the two operating companies, are modern and efficient, although there are differences in both mining and smelting practice. It is the consistent policy of both companies to adopt all modern improvement in plant or treatment. Even during the present time of acute pressure the Canadian Copper Company has materially increased its output without substantial enlargement of its plant, and the losses in smelting are less, both at Copper Cliff and the Mond plant at Coniston, than they were a year ago. These companies have each had its experimental stage, neither has asked nor received any Government assistance, and both have earned the success which they have achieved.

"(6) The present system of mining taxation in Ontario is just and equitable and in the public interest, and is the best system for this Province. Any question of change is rather one of rate than of principle.

"(7) Experiments have been undertaken by the Commission in the production of nickel-copper steel direct from Sudbury ore, and also in the electrolytic refining of nickel. Certain improvements in the latter process have been made the subject of application on behalf of the Government of Ontario for patents in Canada, the United States, and Great Britain."

Public interest in the nickel question has been, and is still, very keen. It has been a matter of popular belief that Ontario has a practical monopoly of the world's nickel, and there has been something like exasperation in the public mind because of the fact that none of the nickel mined in Ontario was refined in Canada, but that it was being sent abroad for treatment.

The opening chapter of the report deals with the agitation which has gone on from the beginning of the industry in favour of the refining of nickel in Ontario, and the various steps which Governments or Parliaments have from time to time taken to realise this desire; the negotiations with the Imperial Government for the same purpose are also summarised. The offer of the Ontario Government to the British authorities in 1891, to give the latter a substantial, if not a controlling, interest in the nickel mines of the Province, if they would agree to establish refining plants and make nickel-steel here, is recalled. Doubt is cast, not upon the good faith of the offer, but upon the possibility of implementing it, if it included only the nickel deposits at that time remaining in the possession of the Crown. It is stated that most of the great deposits now being worked had already been parted with before the date of the offer. Nevertheless, the report says that the action of the Government was a notable one, arguing remarkable insight into the future, and "had the offer been met with an equal degree of imagination on the part of Great Britain, it is not easy to say what the results would have been. Even with the deposits found since 1891, a good deal of nickel could have been obtained, and it could always have been possible to purchase privately-owned properties."

The Commissioners say that at the beginning of their inquiry it was asserted by the companies interested that nickel could not be economically refined in Ontario. They, therefore, naturally express gratification at the assured prospect of the erection in Ontario of two large plants for the refining of nickel. One is now being constructed by the International Nickel Company of Canada, Limited, at Port Colbourne. The company has obtained a site of 400 acres, on which 2,000 men are now at work, and is erecting a plant whose initial output will be on the basis of 15,000,000 lb. of nickel per annum, provision being made for doubling or quadrupling this capacity. The matte to be refined here will come from the smelters of the Canadian Copper Company at Copper Cliff, for the treatment of which there will be required bituminous coal, coke, fuel oil, nitre-cake, and other chemicals and materials, estimated at 100,000 tons annually. The plant is expected to be in operation and

turning out refined nickel in the autumn of the present year. The second refinery is that of the British-America Nickel Corporation, Limited, a company controlled and largely financed by the British Government, which has purchased the large Murray Mine, the Whistle, and other deposits in the Sudbury region. This refinery will probably be erected at the Murray Mine, which is about three miles from Sudbury. The refining process employed will be the electrolytic, otherwise known as the Hybinette process, from the name of the inventor who uses it in the Norwegian works. This plant will have a capacity at the beginning of 5,000 tons of nickel per annum.

As to compulsory measures for ensuring that the whole of the nickel output of Ontario should be refined within her borders, the Commissioners say that they are advised that the Provincial Legislature has not power to prohibit export or to impose an export tax directly, and that the power of the Province in effect to regulate export by differential taxation in favour of nickel refined within the Province is a matter of grave doubt. The completion and operation of these plants, in the view of the Commissioners, especially because of the probable extension of the facilities now being provided, will go far towards a solution of the question of home refining, which has so long exercised the public mind. The output of these refineries, added to the nickel now being produced in England from Ontario matte, will fully meet, if not surpass, the entire requirements of the British Empire raised in connection with the nickel deposits. The Commissioners point out that to expropriate the deposits and plants of the Sudbury nickel area would probably cost not less than $100,000,000, a sum approximately equal to the total paid-up capital of all the chartered banks in Canada. They add :—

"There is no certainty that large profits can be made every year from the nickel industry. The present activity is in part due to well-understood causes, which it is to be hoped will never recur. In the past the output has had to be curtailed at times. If the price of nickel should fall, profits will naturally decrease. The nickel industry is to a considerable extent dependent for its success on the highly trained and specialised technical men who superintend it, who command salaries far beyond those which are paid in the Government service to the most highly-placed employees. Besides, nickel is not a necessity of life, nor an article of universal consumption or use, and the nickel business is in no way comparable to those connected with the operation of public utilities, where Government ownership may be beneficial or expedient. In short, there does not seem to be any good reason why the people of Ontario should be asked to adventure so large a sum of money as would be required for the purchase of the nickel deposits and plants."

The uses of nickel are dealt with in several chapters, under the headings: "Properties and Uses of Nickel and its Compounds"; "Non-Ferrous Alloys"; "Nickel Steel and other Alloys of Nickel containing Iron." The great use of nickel is in the manufacture of nickel-steel, the ordinary form of which contains about 3½ per cent. of the metal. As compared with ordinary carbon-steel, nickel-steel has much greater strength and ductility, and is used in various forms in a wide range of industrial operations, also in the manufacture of armour-plate, ordnance, projectiles, protective deck plate, gun shields, and many other articles of naval and military equipment. Large bridges at New York, and over the Mississippi and Missouri rivers, dams, docks, and spillways of the Panama Canal, and other great structures illustrate the usefulness of nickel-steel. For locomotive forgings, marine engines and shafting, wire cables, automobile parts, etc., there is a large and growing use. Many useful alloys of copper and nickel are produced and used for a variety of purposes, such as bullet-casings, coinage, plumbers' supplies, etc.

The use of nickel in the electro-plating of metallic objects is widely known and needs no explanation. As finely divided metal, nickel is used as a carrier of hydrogen in the manufacture of fats from oil, and this property is largely made use of by soap-makers. Pure nickel is used in coins, in making watch and cigarette cases, and cooking utensils. It is also drawn into wire used in spark plugs and electrical leading-in wires. Purchasers and leading consumers in Britain and the United States express the opinion that the uses of nickel will be extended, and that when normal peace conditions are fully restored the demand will be greater than it was before the war. A reduction of the price would undoubtedly encourage consumption and require increased production.

Chapter IV., on the nickel deposits of the world, contains 191 pages, and is in itself a complete treatise on this subject. The Sudbury deposits are first taken up and their geology, mineralogy, and composition fully discussed. The extent of the ore reserves is given at

70,000,000 tons of proven ore, and of proven, probable and possible ore at 150,000,000 tons. Mining methods are described and illustrated. New Caledonia is generally held up as the chief competitor of Ontario in the production of nickel, and the deposits there are dealt with; the ore is different from that of Sudbury, and does not contain copper. It is shown that while there is a good deal of nickel in New Caledonia, the mines are small compared with those of Sudbury. The largest mine yet worked contained 600,000 tons; few exceed 250,000 tons, while in Sudbury the large deposits have tonnages ranging up to 45,000,000 tons. The ores as shipped are richer in nickel than those of Sudbury, but are gradually lowering in tenor, they are more expensive to work, are further away from markets, and the production is increasing very slowly. While the output of the Sudbury mines has grown nine-fold during the last fifteen years, that of New Caledonia has increased by only 20 per cent. The conclusion as to New Caledonia is summed up in the following words:—

"The essence of the whole matter, in so far as competition from New Caledonia in the open market is concerned, is the cost of the refined nickel produced from these ores. More than a dozen years ago the cost was approximately 19 cents a lb.; immediately prior to the war it had not been lowered; at present, with excessive freight rates and increased prices for supplies, the cost is much increased. As long as the price of nickel remains about the same as it has been during recent years, New Caledonia will have an important industry. It will probably expand to some extent, owing especially to the activities of the newer of the two companies that are shipping ore and smelting on the island; but there is no good reason for believing that the competition from New Caledonia will become any stronger than it has been in the past. Should the price of nickel fall to 25 cents a lb. or less, New Caledonia will have difficulty in keeping her mines in operation."

The nickel mines of Norway are dealt with. They are of the same character as those of Sudbury, but poorer in both nickel and copper. The deposits are small, and the output is not capable of very large expansion. The electrolytic process of refining is employed in Norway, and all the Norwegian nickel since the beginning of the war has been going to Germany.

There are many other countries in the world which contain deposits of nickel ore, including Germany and Austria, France, China, Russia, Egypt, Italy, Tasmania, United States, etc. Most of these deposits appear to be of limited extent. In Madagascar the ores are similar to those of New Caledonia, but have never been worked. In the island of Soboekoe near Borneo, and in Cuba, there are large and doubtless important deposits of nickelliferous iron ore. In Seboekoe they have never been worked, while in Cuba operations have been going on for some seven or eight years. Neither, however, can be regarded as a source of metallic nickel, and the shipments from Cuba do not appear to be increasing.

The Commissioners conclude, that while it is true Ontario has no monopoly of nickel, it possesses many advantages over all competitors, even under the present conditions of the market as to prices and trade connections. In any keen competition as to prices, it is doubtful whether any locality at present known or suggested could compete with Ontario. It is a matter of record that at one time of low prices the leading New Caledonia company was compelled to suspend its dividends. It may be doubtful, further, whether anything but an arrangement of the market between the great interests can prevent the complete domination of the world's trade by the nickel industry of Ontario making the best use of its exceptional resources.

A chapter of the report is devoted to the history and development of the principal operating companies connected with the industry in Ontario from its inception. The organisation of the Canadian Copper Company is traced, and the merger of 1902 by which the International Nickel Company absorbed that company and the Orford works, and thus united under one control the mines and the refining process, is set forth. A table shows the exports of metallic nickel by the International Nickel Company for the ten years previous to the war, and also for the period from the beginning of the war to December 31st, 1916. The former table shows that Germany and Great Britain, France, Russia and Italy have taken nearly all the overseas shipments since that time, none going to Germany. Prior to the war, nickel, in whatever country produced, was sold like any other metal wherever there was a market for it, and was treated solely as an article of commerce without regard to international relations. A schedule is given showing the countries in which the shares of the International Company are held. This covers 89,126 shares of preferred stock, and 1,673,384 shares of common stock. The great

bulk of the shares are held in the United States, Canada and Great Britain coming next. Only 256 shares of preferred and 452 shares of common stock are held in Germany and Austria. Full details are given of the reorganisation of the International Company in 1912.

On December 31st, 1916, the common stock stood at $41,834,600 and the preferred at $8,912,600, making a total share liability of $50,747,200. Another table shows common stock dividends paid from 1910 to 1916, a total of $30,942,238. The profits from 1903 to 1916 aggregated $39,850,356, total assets $61,230,813. Little further allusion is made to the question of any possible exports of nickel to Germany during the war, the Commissioners stating that this question was not within their jurisdiction. The Mond Nickel Company operates on a smaller scale than the Canadian Copper Company. It works the Garson, Worthington, Lovack, Victoria and Kirkwood Mines, the ore from which it smelts at the plant at Coniston, erected two or three years ago. The matte is sent to Clydach in Wales, where it is refined by the Mond process, invented by the late president of the company, Dr. Ludwig Mond. The products of the refinery are metallic nickel, nickel salts, and copper sulphate; the market for the last is in the vine-growing countries of Europe, where it is used to combat the enemies of the grape.

Several chapters of the report are devoted to a description of the metallurgy of nickel, the roasting and smelting of the ore and the bessemerising of low-grade matte. The Bessemer matte contains about 80 per cent. of nickel plus copper, the Canadian Copper Company's product containing about 53·5 per cent. nickel and 25 per cent. copper. That of the Mond Company is lower in nickel and higher in copper, containing about 40 or 41 per cent. of each. The Orford, Mond and electrolytic refining processes are described and compared, the Commissioners remarking that the respective costs of producing refined nickel from the Sudbury ores by each of the three processes mentioned do not differ to such an extent as to give any one process a material advantage over the others in competition. Costs of production are gradually falling, through increased efficiency and larger output, and may be still further reduced, though war conditions are for the present exercising an influence in the opposite direction.

The use of the electrolytic process, which the Commissioners regard as most suited to Ontario conditions, by all the companies operating in Ontario would not prevent their meeting competition from any other quarter. This process can be operated as cheaply and efficiently in Ontario as in Norway. The Mond Nickel Company give their reasons for not refining in Ontario. These are founded on the greater expense due to higher wages, increased cost of fuel and chemicals, higher freight charges, and the necessity for quick delivery of copper sulphate to Mediterranean ports during the season when it is required.

Some space is devoted in the report to a possible product from the Sudbury ores or slags, namely, nickel-copper steel. There has been a prejudice against the presence of copper in steel, but much recent experimentation has tended to show that the prejudice is unfounded, if the copper percentage is not too high. Indeed, there is reason to believe that the presence of a limited proportion of copper in steel is beneficial, and also that it is capable of replacing a proportion of the nickel in nickel-steel up to at least one-third of the combined quantity of nickel and copper. Experiments made for the Commission by Professor Guess, of Toronto University, fully confirmed these conclusions. Copper also appears to assist steel in resisting corrosion.

The production of nickel as a by-product was investigated by the Commission. Such production is of considerable importance. By-product nickel comes mainly from the electrolytic refining of blister copper, copper ores almost invariably carrying a small proportion of nickel. About 815 tons of nickel were obtained in 1915 from the refining of copper in the United States, and the tremendous production of copper going on in that country will largely increase this quantity. In addition, scrap metal containing nickel is continually being re-treated and the nickel recovered. The production of by-product nickel, though small in comparison with the output of ores worked for that metal, has much bearing upon possible supplies of non-Canadian nickel for export to enemy or other countries.

The Commissioners point out that the importance of the precious-metal contents of the Sudbury ores has not in the past been fully recognised. These consist of gold, silver, platinum, palladium, iridium and other rare elements. The proportions of these metals which the ores carry are minute, and appear to vary in the several deposits. Roasted matte from one of the companies showed ·1235 oz. platinum and ·197 oz. palladium, ·027 gold

and 1·84 oz. silver, while the other company's matte showed platinum ·988 oz., palladium ·984 oz., gold ·236 oz., and silver 6·155 oz. per ton. Platinum is at present very scarce and the price unusually high; palladium is being substituted for it wherever suited. Both these metals are now worth at least five times as much per ounce as gold.

The Orford refining process recovers a much smaller quantity of the precious metals than the Mond and electrolytic processes. The recovery of the metals of the platinum group constitutes an interesting chapter of the report. It states that the platinum and palladium contained in the Copper Cliff mattes for the year 1916 would be worth $794,600.

Losses in mining, smelting, and refining are discussed in the report. These are stated to be considerable. Certain losses are inevitable at each of the successive stages of treating the ore. In mining, heap-roasting, smelting, converting and refining, such losses cannot be wholly eliminated. In smelting there is not much reason to anticipate that further saving of the metals can be made. The abolition of heap-roasting would make a small saving in nickel and copper. The whole of the sulphur in the ore must be got rid of, and at present it all goes to waste. The question of the possible recovery and utilisation of sulphur fumes is given a chapter in the report. Fumes from the roast-heaps are objectionable and injurious, and there is no means of collecting the sulphur given off from the heaps. A million tons of ore contains sulphur enough to make a million tons of sulphuric acid, but sulphuric acid could only be produced at a heavy loss, since the freight charges to markets on so bulky an article would cost more than it is worth.

A chapter is devoted to statistics of nickel production, showing the output of Ontario, New Caledonia, Norway and other countries.

The important subject of taxation is dealt with in the concluding chapter. The Commissioners were instructed to report upon a just and equitable system for taxing, not only nickel and copper mines, but mines of all kinds. Their report is that the present method of taxation on net profits is the fairest and best. In their opinion, the present rate of 3 per cent. should not be raised beyond 5 per cent. Gold-mining companies occupy a unique position; their product has a fixed price of $20·67 an ounce, and while all other metals have advanced, some of them very materially, the gold companies get no more for their product than before, yet their costs are largely increased by the higher prices for labour and cost of supplies.

The report seems to cover every conceivable phase of the nickel question, at any rate in relation to industry and trade, and will form a veritable encyclopædia of information for many years to come.

TRADE METHODS OF SICILIAN LEMON INDUSTRY.

The cultivation of lemons has been one of the important industries of Sicily from time immemorial, but it has made decided advances in the last decades. There are no statistics to show the number of trees now growing. In 1898 it was estimated that there were 6,000,000 in the island of Sicily. From calculations made from the production in 1915 and the acreage under cultivation, it is thought that there are now between 11,000,000 and 12,000,000 trees. Statistics for June, 1916, show that there were 88,797 acres planted in lemons, oranges and mandarins, the larger proportion being lemons. The production of these fruits in all Italy in 1915 was 560,500 metric tons, while of lemons alone it was 534,300 tons.

Very few of the lemon growers, writes the United States Consul at Palermo, export their own crop. As a rule, the grower sells his lemons on the tree to a shipper or buyer for a factory. There is no organisation of the proprietors, and each one sells when and where he deems best. The shippers, as a rule, buy a whole orchard at so much per thousand and then gather the crop as they think opportune. Sometimes the different crops are sold separately. If the crop is sold as a whole the buyer usually does the harvesting, but if each picking is sold the work is done by the proprietor.

In general, when the shipper buys a crop he pays one-third of the price at the time of making the contract, one-third at the time the gathering is begun, and the remainder when the gathering is completed. When the fruit is shipped the banks advance a certain sum on account on presentation of the shipping documents. This sum varies according to the shipper or according to advices from London. If the lemons are shipped on account of the exporter, the bank usually advances 40, 50, or 60 per cent. of the value, but if the exporter has credit at the bank the entire value may be advanced. If the shipment is made for account of any importer in New York or in London, the local bank will advance only on advice of a bank in New York or London.

Lemons are sold at auction in all countries except Russia, where they are shipped on order. Auctions are maintained in normal times in New York, London, Hamburg, Cologne, Berlin, and Budapest. Efforts have been made at times to form a combination of the shippers in Sicily and to establish the business on a firm basis, but these have always resulted in failure. It has been the desire of some of the exporters to sell the fruit on

order, as is done in Russia and as oranges are sold in other countries; but there are too many small shippers engaged in the business to form a combination that would prove effectual.

There is an association of fruit exporters (Lega Agrumaria) to which a majority of the shippers belong, but this organisation has never attempted to change the method of transacting the lemon business. It has protected the shippers in various ways and looked after their interests. It has had charge of the shipping, and all space for cargo on ships must be obtained through the Lega. That is, if the members of the Lega have sufficient lemons to take up all the space on a ship the shipping company cannot take the cargo of others. In this way the Lega might be said to have a monopoly; but it is understood this is seldom, if ever, exercised, and in general space is assigned to the first applicants.

There is little difference in the packing for different countries, except that the English market takes a large-sized case as well as the regular size. Also the English market prefers the large-sized lemons, whereas the American prefers the small fruit. The Russian market requires a medium-sized fruit, but of best quality. Other markets take first and second and sometimes third grade lemons. The average for the American market is 330 to 360 lemons per box.

GINGER INDUSTRY OF SOUTHERN INDIA.

Owing to the war the European and American markets have neglected East Indian ginger during the last two years, and the bulk of the crop has been bought up by the Indian and Arabian trade. Although America has never been a heavy buyer of Indian ginger, yet the purchases from the Madras Presidency have been of consequence for some time past, averaging at least £6,000 a year, says the United States Consul at Madras. In the six months ended June 30th, 1916, exports amounted to 199,344 lb., valued at £3,470; in the calendar year 1915 they totalled 732,368 lb., valued at £7,170.

The best ginger in India is said to be that produced on the Malabar coast and exported from Calicut. It is the produce of the Ernaad and Shernaad districts, 40 to 50 miles from Calicut, in the interior of South India. The following notes, prepared by one of the principal Madras exporters of East Indian ginger, may be said to contain the latest authentic data available locally on this subject :—

The ginger plant (*Zingiber officinale*) is known to have been cultivated in India and China for many centuries. Its most general Chinese name is "kiang." In India the word ginger is believed to come from the Sanskrit "sringavera" through the Arabic "zanzabil"; and from the same source was doubtless derived the corresponding Greek name, ζιγγίβερι. Though not known in a truly wild state the ginger plant is doubtless a native of South-Eastern Asia, and was introduced thence into the West Indies, Africa, and tropical countries generally. The plant is cultivated all over the warmer and moister parts of India, up to an elevation of 4,000 to 5,000 feet in the Himalayas.

In the Madras Presidency the cultivation generally commences in the middle of May after the ground has undergone a thorough ploughing and harrowing. The only suitable kind of soil is good and heavy red earth, free from gravel and not too wet; gravelly ground checks growth of the roots, while swampy soil tends to rot the ginger. At the commencement of the monsoon beds of 10 or 12 ft. long by 3 or 4 ft. wide are formed, and in these beds small holes are dug one foot apart. Selected roots kept as seed from the preceding season are then buried in the holes, the whole bed being covered with a thick layer of green leaves. The plants mature in November, attaining a height of about 2 ft. The leaves and stems then wither away, the rhizomes (root stock) are dug up, the outer peel of the tubers is removed, and the green ginger is washed and dried in the sun.

From December until the end of March the ginger is sent to Calicut to be sold, roughly dried, to the various European export firms, which undertake the curing. The method of preparing is as follows: The dried ginger is washed in large tanks of bricks containing 20 or 30 cwt. of the produce, which, after having been thoroughly soaked and stamped with the foot by coolies, is taken out in baskets and passed several times through clean water. It is then dried on barbecues for three or four days, garbled, and packed for export under the denomination of "brown rough ginger."

Another quality is obtained by leaching the ginger with sulphur in small kilns. Baskets containing about 10 lb. of the article, previously washed, are arranged in rows on shelves in the kilns and exposed for twelve hours or so to sulphur smoke, about 7 lb. of sulphur being used per ton. The produce comes out from the kilns a light brown colour, is dried in the sun, garbled, and packed as "rough bleached ginger."

Finally, a third quality is turned out on a small scale by the following process: Once bleached and dried as above, every piece of ginger is carefully trimmed and scraped with special knives in order to remove the outside tissue. After this it is dipped in a solution of lime water, sent back to the kilns for a second bleaching, removed and dried in the sun for two or three days, bleached a third and last time, and finally dried for the garbling and sizing. Owing to the three consecutive bleachings, combined with the passing through fairly strong solutions of lime water, the ginger pieces are now quite white, and covered by a thin crust

of lime which protects them against worms during the voyage to Europe. The several grades are sorted according to size, and each variety is packed separately in mango-wood cases. It is shipped and sold under the name of "assorted cut ginger," the sizes being A, B, C, and Triages.

The exports from Calicut before the war amounted yearly to about 30,000 cwt., divided between the United Kingdom, United States, and Germany, plus about 20,000 cwt., which were shipped by native traders to Northern India, Arabia, and the Persian Gulf. Prices averaged 30*s.* to 50*s.* per cwt. c.i.f. London, according to quality.

PRODUCTION OF NUX VOMICA IN MADRAS PRESIDENCY.

Among the products exported from the Madras district to the United States in the first half of 1916, nux vomica ranked seventh, following skins, coconut oil, pepper, coir yarn, indigo, and sandalwood, and amounted to 2,666,118 lb., valued at £27,600. In the calendar year 1915 they totalled 1,470,180 lb., valued at £11,000.

Nux vomica is shipped in the form either of seeds or of "pickings," the latter being husks or shells washed from the seeds. The product is of commercial value as being the source of the alkaloids, strychnine and brucine. With the exception of Ceylon, which exports a limited amount of nux vomica, British India is said to supply the world. In addition to the alkaloids just mentioned, the seeds yield a dye which produces light-brown shades on cotton cloth, and an oil employed medicinally by native practitioners in India.

The snakewood, nux vomica, or strychnine tree (*Strychnos nux-vomica*, Linn.) grows wild in the forests, and is also cultivated to a limited extent in gardens in India. It is a moderate-sized deciduous tree of the Gorakhpur forests in Southern India, Bengal, Orissa, the Deccan, and Karnatak, moist forests in the Bombay Presidency, and deciduous forests all over India. According to a report by the United States Consul at Madras, the producing centres in the Madras Presidency are Tanjore, Trichinopoly, Pudukotah, Calicut, Rajahmundry, and Nellore. Shipments go mainly to London and New York; formerly Hamburg was an important mart. The average yearly production throughout India is estimated at 40,000 cwt. Production is under the control of the Forest Department of the Government of India. The seed is included in the general items of minor forest produce, and the right to collect is usually sold to the highest bidder.

Nux-vomica seeds and pickings are obtained from the plum-like fruits of the tree. The fruit is collected and the seeds washed out and dried in the sun, or the seeds are simply gathered from the ground, but in the latter case they have little commercial value. They are roundish, flat, or concavo-convex in shape and silvery in colour. The best seeds are known in the trade as "fine," "bold," and "fresh." Their appearance should be "bright"—that is, clean and silvery. Each nut contains about a half-dozen seeds.

In the forests of Nellore, where the tree is common, the seeds are washed out by a forest tribe, the Yanadis, and a good price is obtained for them. Cochin nux vomica is collected in the dry deciduous forests at the foot of the Travancore hills, and is sold at a low figure to small native dealers, who send it to the merchants. The nux vomica of the eastern coast finds an outlet at Cocanada, and shipments bear the name of Cocanada nux vomica. The Madras seeds come from Nellore and several other parts of the presidency. Madras, Bombay, and Cochin are the ports in India from which nux vomica is chiefly exported.

The quotation for nux vomica in Madras at the end of June last was 1¼*d.* per pound. Nux vomica is packed in robbins or bags usually of 164 lb. when exported, the shipping ton being 14 to 16 cwt. net.

ARTS AND CRAFTS.

Medals Ancient and Modern.—We have grown so used to the theory that the only modern medallists worthy of consideration are Frenchmen that the Exhibition of Medallic Art now open at Messrs. Waring and Gillow's will probably come as quite a surprise to a number of people as revealing the fact that in recent years, however unsatisfactory some of our medals may have been, there really has been a revival of the art of medal designing in this country. The exhibition includes an excellent loan collection of ancient and mediæval medals, but its greatest interest from the point of view of arts and crafts lies in the modern exhibits, most of which have been sent in in competition for the money prizes promised by Earl Beauchamp, Sir William Lever, Mr. Oppenheim and Messrs. Waring and Gillow, and the three silver medals offered by the Royal Society of Arts. The present moment is a peculiarly fitting time for an exhibition of this kind. We in England are not likely to emulate our enemies by striking medals to commemorate actions best buried in oblivion or to ridicule unoffending neutral countries, but we may confidently expect that at some not far distant date medals will be issued as records of the gallant deeds which have been done; and meanwhile medals and small plaques rank amongst the best and most satisfactory forms of private war memorials. The present exhibition proves that we have amongst us artists capable of doing good work of this kind. It is to be hoped that it will be visited

by those public and private persons interested, and that the work which is to be done will be entrusted to the right people.

Serbian Weaving and Needlework.—The little show of Serbian work held in Bond Street early in May was of considerable interest. Although intended primarily as a sale of the work now being carried out by the Serbian refugees in Corsica, it included a loan collection of Serbian needlework and served to show how the arts and crafts of the Balkan State, while in many respects Slavonic, have been influenced by their close proximity to Turkey and by centuries of Turkish domination. It is satisfactory to note that the work encouraged by the Serbian Relief Committee and executed by the refugees shows, on the whole, more affinity with Russian and Southern Slav productions than with Turkish work. Some good rugs and dhurries were on view and some attractive specimens of hand-weaving, but it was the embroidery which provided, on the whole, the most distinctive feature of the exhibition. Most of it was in cross-stitch or in some kind of canvas stitch, and both the colours and the designs were characteristic. The backgrounds were for the most part white or cream-coloured, and there were some dainty collars and blouses embroidered in simple patterns in colours which, though not peculiarly bright, were by no means dingy. The work in brilliant hues on a black ground was, of course, less pretty in the conventional sense, but it was striking and unusual, and it suggested a good many possibilities. Work of this kind could be used with good effect for the decoration and enrichment of dark coats and skirts and dresses, as well as for cushions and upholstery work of various kinds.

Russian Arts and Crafts.—The Russian Exhibition at the Grafton Galleries is, of course, on a much larger scale than was its Serbian neighbour. At first sight the visitor was tempted to say, "This is purely Slavonic work," but a closer inspection of the exhibits helped to reveal the differences of race and climate within the Russian Empire. Yet even here the thoughtful student was struck by the family likeness among all peasant work. The absence of a catalogue made it somewhat difficult to understand the relation of a good many of the exhibits, but one could not fail to be struck by the fact that in different parts of the exhibition two attractive pairs of boots of much the same pattern and colour decorated with precisely the same type of leather appliqué were labelled in the one case as Tartar and in the other as Lapp. That need not, of course, necessarily imply that they came from widely different parts of the world, but it was interesting, especially as both the colouring and the pattern of the work would naturally have suggested an Eastern origin. In this country we are, perhaps, too prone to think of Russian art and craftsmanship mainly in terms of peasant work. It is the peasant embroidery, the peasant jewellery and the rougher types of crosses and ikons with which people over here are generally most familiar. The exhibition serves to remind us that these things by no means exhaust the resources of Russian artistic craftsmanship. It includes some really good ikons and an adequate show of secular metalwork as well as a collection of enamel of the type which most people connect perhaps with Norway and some with Hungary—though history would seem to show that Russia inherited it from the Byzantine Empire—and a certain amount of champlevé. There is also enough jewellery to remind us that Russian work is by no means exclusively peasant, and the various objects made of cut and polished malachite recall Russia's great output both of precious and semi-precious stones. In short, the ordinary Englishman with no special knowledge of Russia who visits the Grafton Galleries cannot fail to come away from them with a somewhat wider view of Russian artistic industry than he had before.

OBITUARY.

LEOPOLD DE ROTHSCHILD.—The death of Mr. Leopold de Rothschild took place at his residence, Ascott, Leighton Buzzard, on May 29th.

He was born in Piccadilly in 1845, and after being educated at home he proceeded to Cambridge. On leaving the University he travelled extensively. Among other countries, he visited Russia, where he picked up some notable art treasures, mainly from the Galitzine collection. He then entered the famous banking house in New Court, and after the death of his father in 1879 became associated with his two elder brothers, the late Lord Rothschild and Mr. Alfred de Rothschild, in the conduct of the firm.

During the lifetime of Lord Rothschild, Mr. Leopold de Rothschild contented himself, for the most part, with acting as coadjutor and counsellor to his brother in the financial and charitable work with which his name was associated; but on his death in 1915 Mr. Leopold de Rothschild took upon himself almost all the public offices held by his brother, especially in connection with the Jewish community. As President of the United Synagogue he became the titular Chief of Anglo-Jewry, and he worked very assiduously in attending the meetings of other public Jewish bodies, and in superintending the details of their work.

For forty years Mr. Leopold de Rothschild was one of the most prominent figures on the Turf, and he owned and bred many famous horses.

He was elected a member of the Royal Society of Arts in 1889.

GENERAL NOTE.

PLATINUM PRODUCTION IN THE URALS.—In spite of the present high prices for platinum, the production of the metal in the Urals during 1916 showed a further decrease. The total output, according to a report from H.M. Consul at Ekaterinburg, amounted to 86,508 oz., as compared with 118,709 oz. in 1915; the production in 1913 was 158,084 oz.; in 1914, 156,755 oz.; while in 1909 it was 214,042 oz. The chief causes of this decline are the shortage of labour, the difficulty in obtaining spare parts for dredgers, and the exhaustion of the richer alluvial deposits. It is confidently expected that new alluvia will be found when extensive prospecting is resumed; but there is no prospect of an improvement in platinum production in the near future, at any rate, as long as the war lasts; on the contrary, it is probable that the output for 1917 will be lower than last year.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 4...Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Very Rev. the Dean of Canterbury, "Some of the Relations between Science and Religion as affected by the Work of the last Fifty Years."

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m.

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. H. M. Ridge, "The Utilisation of the Sulphur contained in Zinc Ore." 2. Mr. G. S. Robertson, "The Rate of Reversion of Mixtures of Superphosphate with Basic Slag and Rock Phosphates." 3. Dr. P. E. Speilmann and Mr. G. Campbell Petrie, "Some Observations on Crude (Coke Oven) Benzoles."

Surveyors' Institution, 12, Great George-street, S.W., 5 p.m.

Geographical Society, Burlington-gardens, W. 8.30 p.m. Brigadier-General Sir Eric Swayne, "British Honduras."

TUESDAY, JUNE 5...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. H. W. Wills, "The City Companies and their Halls."

Royal Institution, Albemarle-street, W., 3 p.m. Professor W. W. Watts, "The Flow of Ice and Rock." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m. The President, "A Great Traverse."

Gas Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 10.30 a.m. (Annual General Meeting.) 1. Address by the President. 2. Report of the Refractory Research Committee. 3. Report of the Gas Lighting, Heating, and Ventilation Research Committee.

8 p.m. Report of the Life of Gas Meters Research Committee.

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Professor W. M. F. Petrie, "Links of North and South."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Mr. R. I. Pocock, Exhibition on behalf of Messrs. Rowland Ward of two Zebra-skins showing abnormal pattern. 2. Mr. D. Seth-Smith, Account of the Poultry Exhibition.

Colonial Institute, Hotel Cecil, Strand, W.C., 8.30 p.m. Captain R. Jebb, "The Proposed Imperial Development Board."

Röntgen Society, at the Cancer Hospital, Fulham-road, S.W., 8.15 p.m. Discussion on "The Future of the British X-Ray Industry."

WEDNESDAY, JUNE 6...Aëronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain B. C. Hucks, "A Further Three Years' Flying Experience."

Geological Society, Burlington House, W., 5.30 p.m. 1. Professor E. J. Garwood and Miss E. Goodyear, "The Geology of the Old Radnor District, with special reference to Algal Development in the Woolhope Rocks." 2. Mr. S. S. Buckman, "A Contribution to Jurassic Chronology."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. G. Embrey, "Some Experiences in the use of Copper Sulphate in the Destruction of Algae." 2. Mr. G. D. Elsdon, (a) "A Combined Reichert-Polenske and Modified Shrewsbury-Knapp Process"; (b) "The Differentiation between Coconut and Palm Kernel Oils in Mixtures." 3. Miss D. G. Hewer, "Note on Orange Pip Oil." 4. Miss N. Elliott and Mr. G. Brewer, "Note on the Estimation of Theobromine." 5. Messrs. H. D. Richmond and J. E. Merreywether, "Rapid Estimation of the Strength of Sulphuric Acid."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor Gerothwohl, "Some Aspects of Rumanian Literature."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. G. C. Druce, "Notes on the Design and Decoration of Misericord Seats."

THURSDAY, JUNE 7...Linnean Society, Burlington House, W., 8 p.m. Professor F. O. Bower will deliver the Hooker Lecture.

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. G. T. Morgan and H. P. Tomlins, "The constitution of internal diazo-oxides (diazophenols)." (Part II.) 2. Messrs. F. L. Usher and B. S. Rao, "On the determination of ozone and oxides of nitrogen in the atmosphere." 3. Mr. J. Taylor, "Thiocarbamide and esters." 4. Mr. H. Bassett, jun., "The phosphates of calcium. Part IV.—The basic phosphates." 5. Mr. J. Thomas, "Preparation of secondary arylamines free from primary amines." 6. Messrs. A. Forster, C. Coope, and G. Yarrow, "Some double compounds of ferric chloride with ethers." 7. Mr. D. B. Meek, "The absorption spectra of some polyhydroxyanthraquinone dyes in concentrated sulphuric acid solution and in the state of vapour." 8. Mr. P. C. Ghosh, "Action of acetaldehyde ammonia on quinones." 9. Mr. A. Tingle, "The exact determination of morphine in complex mixtures. Part I.—A collection and revision of data."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. A. C. Benson, "The Art of the Biographer." (Lecture II.)

FRIDAY, JUNE 8...Royal Institution, Albemarle-street, W., 5.30 p.m. Professor Sir J. J. Thomson, "Industrial Applications of Electrons."

Astronomical Society, Burlington House, W., 5 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, JUNE 9...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "The Electrical Properties of Gases." (Lecture VI.)

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FRIDAY, JUNE 8, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, May 8th, 1917; THE RIGHT HON. LORD BLYTH, Chairman of the Colonial Section, in the chair.

THE CHAIRMAN said the meeting would agree with him that Captain Millet had paid the Society a great compliment in coming to London from Paris expressly for the reading of his paper. He was well qualified to speak on this interesting subject, having spent much of his youth in North Africa, where his father, the distinguished French diplomatist, Monsieur René Millet, served for six years as Régent-Général for Tunis, a post corresponding to that of Agent and Consul-General held by the late Lord Cromer when he was in Egypt. From a conversation he had had with Captain Millet he thought they would find that the author of the paper was as much an Englishman as a Frenchman, and it might interest the audience to know that he was a year at Harrow School as French master in exchange with an Englishman who desired to spend the same time in a similar position in one of the principal educational establishments in Paris. Since the outbreak of war Captain Millet had been employed with the British Army in France as liaison officer, and he was the author of several works relating to this country, one of which had been translated and published under the title of "Comrades in Arms." He was for some time the London correspondent of *Le Temps*, and was now the Colonial editor of that important journal.

The paper read was—

PROBLEMS OF FRENCH NORTH AFRICA.

By CAPTAIN PHILIPPE MILLET,
Colonial Editor of *Le Temps*.

In the year 1868 the well-known writer, Prévost-Paradol, advised his country to look for its future across the Mediterranean Sea. "Our supreme chance," he wrote, "lies with Algeria. It is a fertile country, which, by the nature of its soil, marvellously suits a nation of farmers. . . . . It is a country near enough to our own, so that the French colonist, who does not like to lose sight of his own parish church, will not consider himself an exile, but, on the contrary, will be able to follow from over there the affairs of the Mother Country. Finally, owing to its position near our coasts and to its own shape, it is a country easy for us to defend. . . . . May the day soon come when our countrymen beyond the sea, finding their establishment too narrow, will spread on both sides over Morocco and Tunis, and thus found at last this Mediterranean Empire, which will not only satisfy our pride, but which will, in the future state of the world, be the last resource of our greatness!"

My object in quoting these words of Prévost-Paradol is to make you realise why, although Alsace-Lorraine is going to be French again to-morrow, as it was two years before 1870, the future of North Africa will remain to France as vital as ever. To-morrow, as in the days of Prévost-Paradol, it will be evidently clear that a nation of only forty million inhabitants or so is bound to become, sooner or later, a second-rate Power unless it finds, in some other part of the world, an opportunity for adding new forces to its own. Of course, the French Colonial Empire, taken as a whole, is going to play an important part in this respect. But I daresay that the rest of this Colonial Empire cannot be put on the same level as North Africa, owing to the peculiar nature of this latter part of the French territories outside Europe. The truth is North Africa is to us much more than a mere colony. Although it does not, of course, compare in size or in future with your great Dominions, it is to us much more than a Dominion. It is a new France, or, if you prefer, a prolongation of the French territory on the other side of the blue sea.

In order to emphasise this exceptional character of our establishment in North Africa,

let me point out a few dominant facts which will illustrate what I mean.

In the first place, there is the geographical situation of the North African Empire. If you look at a map, you will notice that the three countries into which it is divided, namely, Algeria, Tunis and Morocco, not only form a single whole, but constitute together a real island. This island is surrounded on three sides by the sea, on the other by the desert. It is much nearer to Europe than to the rest of Africa. As a matter of fact, in the time of the Roman Empire it was a part of the European system, and France has done nothing else than renew a tradition which had been broken by Islam. This new connection between the two shores of the Mediterranean is bound to become closer and closer every day. It takes only twenty-four hours at present to sail from Marseilles to Algiers. It will take less to-morrow. Now I ask you to fancy what would be the political consequences for the future of the United Kingdom if the whole of Scandinavia were British. For, as a matter of fact, the distance between Marseilles and any point on the northern coast of French Africa is shorter than the distance between London and Christiania. Surely, such a British establishment would be much more comparable to Ireland than to a dominion beyond the ocean.

This African country so near our own is, without any doubt, one of the richest of the world. Visiting to-day any of the great towns on the coast, Algiers, for instance, or Oran, one cannot help being struck by the enormous economic development which is testified by the continuous growth of the harbours and the cities themselves. Although it would be perhaps somewhat ambitious to compare this mushroom growth with what is taking place in North America, there is certainly a great analogy between these places and some South American cities, such as Buenos Aires. This impression is confirmed by trade statistics. Although Morocco is only beginning to develop its resources, the total trade of North Africa amounted before the war to a little over £72,000,000 a year. Out of this total, about £40,000,000 represented trade between North Africa and the Mother Country. I am not quoting this last figure in praise of a Protectionist policy, which, I fear, has been deplorable in many ways, but only in order to show you that the trade between France and North Africa amounted before the war to nearly half the trade between France and her best customer, the United Kingdom. Moreover, the present wealth of this African France is certainly nothing as compared with what it will be in the future. It has been calculated that the area of arable land contained in the North African island is equal to all the arable land of Italy and Spain put together. Only a fifth or a fourth part of it has been, up to now, put into cultivation. I need scarcely add—for the facts are well known—that the mineral wealth is equally considerable, not only in Algeria, where the enormous iron deposits of the Uenza region have not as yet been touched, but very likely in Morocco as well. The Germans knew it well, and the manifold intrigues of the notorious Mannesmann brothers, of whom I shall have to speak again later, are ample proof of the importance the Boches were kind enough to attach to our treasures. In a word, North Africa is one of those countries of unlimited possibilities which afford to an old nation an indefinite outlet for its economic energy. Were we Germans, we should certainly thank our special God for having put at our very doors a sort of home Eldorado.

But neither the geographical situation nor the economic prospects are sufficient to explain the prominent place of North Africa in the national life of modern France. What makes it so important in our eyes is the presence, from one end of the Atlas to the other, of a mixed population which is a living reserve of energy. I wonder if many people are aware that the European population over there is not much inferior in number to that of South Africa. Of course, out of 800,000 Europeans contained in Algeria alone, only 500,000, according to the census of 1911, were French citizens — a figure to which must be added about 50,000 Frenchmen in Tunis and 40,000 in Morocco, where the increase is more rapid than in any other part. It is also not to be denied that out of this French population a great number have become French by naturalisation. But what precisely makes North Africa so interesting to us is that it enables France to absorb, gradually, a great quantity of new European blood, mainly Spaniards and Italians, by the very same process which allows the United States every year to turn into American citizens thousands of immigrants from all parts of the world. A little fact will illustrate this. In 1912 the French elementary schools in Algeria contained, besides about 75,000 French boys and girls, 44,000 boys and girls of foreign nationality. This shows that

almost all the European children are educated in French schools. In the course of one generation or two they are bound to become part of the French nation, just as the son of the Slav immigrant in the United States quickly forgets that he is not an American citizen by origin. Add to this the fact that the French birth-rate in Algeria is extremely high indeed. All this explains how it is that the French population in Algeria alone has increased in the proportion of one to four within the last forty years, and is likely to increase in the future at the same rate throughout North Africa, thus providing France with additional new blood which she would not find in the ranks of her home population.

The native element is equally important. Of course, being Mohammedan, the North African natives have many features in common with the Egyptians. I need not add, therefore, that it is not very easy to bring them to understand our ways. I shall have, presently, to deal with the ominous question of how to make Mohammedans live in peace side by side with Christians. But this native North African population is in many ways nearer any of the European races than the rest of the Mohammedan world. Out of a total population which, in our ignorance of the real man-power of Morocco, is only estimated at present at ten or eleven millions, I should say that about nine million at least are pure Berbers. This means that not only they are white men, but that, being Celts by origin, their type and temper make them a sort of intermediary between the Arabs and the Europeans. This is especially the case with the curious population, numbering about two million Mohammedans, which live in the mountains in the Kabylia, a district as crowded in many places as Flanders. These men have their little faults, just as, I suppose, we have ours. They are hot-headed and always have been. In the early periods of Christendom they were always on the side of the enthusiastic heretics who found such a pleasure in destroying Roman farms in order to please God. They have, so to speak, always been a kind of Conscientious Objectors. At the same time, however, they are not only first-rate fighters but good workers as well. A curious symptom of their enterprising spirit is the fact that, a few years before the war, a great number of them had taken the habit of coming to France in order to work in various factories. Once they are clad in European clothes, sometimes even discarding the national headdress, known under the name of Chechia, it would be often difficult for a casual onlooker to distinguish any of them from a French working-man from Auvergne or Burgundy. The same disposition is equally noticeable among the Moroccans. It proves that these Easterners are quite capable of playing their part side by side with the Colonists in the economic development of the country. In a lesser degree than the Europeans they are a distinct asset to the man-power of France. Besides, although their growth in numbers is not exactly as rapid as that of the Europeans, one cannot help being struck by the fact that the native population of Algeria has doubled since 1866.

Perhaps the best way to illustrate all this is to recall the help the Mother Country has derived during the war from the young country beyond the sea. This, after all, is the crucial point. Just as the vigour of the British Empire has asserted itself by the magnificent support the Dominions have given to the Mother Country, it is possible, in the same manner, to forecast something of the future strength of France by counting the men who have come from North Africa to take their share in the common fight. Of course, a great handicap resulted during this war from the state of unrest which still prevailed in Morocco, and which reduced to a trifle the contribution in first-rate soldiers we are sure one day to derive from that part. In spite of that, North Africa has been able, not only to help France economically, but also to supply her with a very substantial contingent. The only official figures published to that effect are those which concern Tunis. The French War Office is very reticent, and we have to put up with that form of hardship as many other little sufferings, such as the rationing of sugar and meat. All the same, it is not very difficult to give a round estimate of what has been, up to the end of last year, the effort in men made by North Africa. The French contingent, properly speaking, most of which constitutes the main part of our numerous Zouave regiments, has certainly not been less than 100,000 men. As for the native contingent, which has mainly been raised in Algeria as well as in Tunis through a mild form of conscription, it consisted up to the same date of about 50,000 Tunisian natives and over 100,000 Algerians, to whom must be added about 20,000 Moroccans, who all volunteered for the war. All these contingents added together make an aggregate force of at least 270,000 men—a figure which only includes those

who are actually fighting or going to fight, but which does not take into account about 50,000 workers sent to the factories in France. Given the fact that a third of North Africa has been and still is in a state of internal unrest, this total may, I think, be considered rather promising.

You are now in a position to understand exactly what I mean by saying that North Africa is to us not so much a colony as another France whose future is bound to react upon our own. Already to-day this African France, which is still in its infancy, is adding a substantial strength to that of the old country. It will play a part ten times more important to-morrow. In twenty or twenty-five years from now, when Morocco will have been completely pacified, when both the French and native population will have increased to a total which will certainly be not less than 20,000,000, the political weight of France in the modern world will not merely be that of a European country of a little more than 40,000,000, but it will correspond to the fighting power of a nation extending over both banks of the Mediterranean lake, and having at its disposal besides economic resources of an exceptional value, the combined man-power of its own race, both European and African, and of a native population which ranks among the most soldier-like in the world. Mind you, I do not think I am carried away by the epidemic of enthusiasm which, for some unknown reason, seems often to be inseparable from colonial speculations. When Prévost-Paradol was prophesying that a day would come when 80,000,000 Frenchmen of French blood would live between the English Channel and the Atlas Mountain, I am afraid the good man was indulging in a wild dream. In speaking of the future, I have tried, on the contrary, to make a conservative estimate, entirely based on facts which anybody can easily verify. What I want you to bear in mind is that, after the question of the French border in Europe, there is nothing more vital to France than the destiny of North Africa. In regard to the question of how to organise and to protect North African France, all other, properly speaking, Colonial problems are, from a French point of view, of secondary importance. Moreover, I feel quite sure that the British point of view in such a matter is bound to be the same as the French one. The war has taught the French to regard the existence of a strongly united British Empire as the best safeguard for the future peace of the world. For the same reason, I have no doubt that the welfare of this North African France, which matters so much to the French nation, will be exactly as dear to the British as to ourselves.

Now the problems connected with the very existence of French North Africa are naturally quite numerous. The material development of the three countries which constitute this Mediterranean Empire would be sufficient in itself to absorb the thoughts of many a statesman. There are, however, two other problems which have become especially acute since the war broke out, and which will have to retain our attention even when the war is over. One is the question of how to organise politically the natives in North Africa, and more especially in the country which is the keystone of the whole building — Algeria. This question primarily concerns the French themselves, although I believe it affords to a British student of Eastern questions something more than a mere academical interest. The second question is how to ensure the present and future safety of the country. It is, before all, a diplomatic question, and therefore affects the interests of our Allies as well as our own.

It is only too easy to understand why the war should have given a pressing character to the problems involved in our policy towards the natives. Not only have the natives been called upon to enlist voluntarily in the French Army, but, in Algeria as well as in Tunis, the necessities of war have compelled the French Government to apply to the native population a certain form of conscription. Such a system was already in force in Tunis when Tunis became a French Protectorate. The war has not, therefore, introduced into that part of North Africa any substantial innovation. The case, however, was not exactly the same for Algeria. Although a decree of February 3rd, 1912, had theoretically introduced conscription for the natives in Algeria, the measure had been applied before the war only to a quite insignificant number of the population. It is only since the war broke out that, in order to fill the ranks depleted by very severe losses, the French Government found themselves compelled to extend conscription, though in a milder form than in France, to practically the whole of the natives. But the consequences of such a new departure are obvious to anyone informed of the spirit of Eastern peoples. Already before the war, as a result of the decree of 1912, the educated

part of the native population had insisted on being granted a number of political and social concessions which they justly claimed to be due to them as a sort of compensation. This demand can only become more pressing after a war in which many Algerian natives have had to perform their duty towards the defence of France almost as has done every average French citizen. Add to this that not only their sacrifices will have been great, but that many thousands of them will have lived in France for several years, either as soldiers or as workers; that during this whole time they will have been brought into close touch with the most modern form of civilisation, also that they will have been treated by the home population with a regard they were not accustomed to find at the hands of our gallant but somewhat rough colonists. There is no doubt that justice as well as enlightened self-interest will compel us to grant them concessions of a liberal kind, if only to prove that the French democracy is not ungrateful. The only question is in what direction we ought to move, and how far we ought to go.

Before I proceed any further, may I point out the exceptional features of this native problem, such as it is to be found to-day in Algeria? The main difficulty does not lie only in the fact that Algeria was our first experiment in North Africa, and that instead of keeping there all the native institutions as we have done under the form of a protectorate in Tunis as well as in Morocco, we have installed over there a system of direct administration the principle of which was certainly clumsy. For Algeria, as you perhaps know, has been to us from the first a sort of Irish problem, which up to now we have not managed to solve in a satisfactory way. We have given a kind of Home Rule to the Colonists, but our native policy has often fluctuated and has not been devoid of undeniable blunders. But there is another reason which explains both our difficulty and the difference between our Algerian experience and some of your own. This reason is to be found in the co-existence, in the same country, of a large European colony and of a strong native race. Where the European colony is confined to a few townsmen, as in Egypt for instance, or where the native race is distinctly inferior, as in South Africa, it is not quite as difficult to devise a political organisation which, while preserving the rights of the Europeans, will more or less satisfy the aspirations of the natives. But our good or, if you prefer, our bad fortune has resulted in both the towns and the land in Algeria being partly in the hands of a numerous European element and partly in those of a Berber race which is the most active and enterprising of Africa; also the French element rightly claims that it must retain the sovereignty over the whole of the country, while, on the other hand, the natives are equally right in claiming that they must have a voice in the administration of local affairs. The problem is, therefore, unique in its nature. At any rate, it is not easy to solve.

What, then, shall be our policy after the war? Shall it consist in furthering complete assimilation between the natives and the French colonists? I hasten to say that, although this radical solution is being advocated by some well-meaning politicians, no sane man dreams of repeating the blunder we made in 1871, when the whole mass of Algerian Jews were made naturalised Frenchmen by a stroke of the pen. There is at least one clear and definite reason why such a radical policy of naturalisation would be doomed to failure, and this is that the Algerian natives are Mohammedans. I cannot do better than quote the very remarkable warning it was my good fortune to receive on this matter one year before the war from Lord Cromer himself. "The Arabs," he wrote, "have a proverb: 'All Christians are of one tribe.' That is the spirit which in reality inspires the whole Moslem world." And in order to point out to me the impossibility of ever inducing a Mohammedan people to abandon wholesale their own traditions and take to the spirit of Western civilisation, Lord Cromer sent me an extract from Sir Charles Eliot's book, "Turkey in Europe," containing a delightful anecdote, which I beg permission to read to you:—

"'Once,' said the Vali, 'I was a very young man, and went a ride with my old father. I was foolish then, and my head was stuffed with silly notions and liberal ideas. I spoke much as you have spoken. I told my father we ought to reform our Constitution, systematise our administration, purify our family life, educate our women, introduce liberal ideas, and imitate Europeans. And my old father answered never a word. So we rode on along the banks of the Bosphorus. At last we came to a Christian village, and round the Christian village were many pigs. Then my father said to me: 'My son, what seest thou?' I replied: 'Pigs, my father.' 'My son,' he said, 'are they all similar in size and colour, or do they differ?' 'They differ, my father. There are big pigs and little pigs;

white pigs and black pigs; brown pigs and mottled pigs.' 'But are they all of them swine, my son?' 'All, my father.' 'My son,' he said, 'it is with the Christians even as with the pigs. There are big Christians, and little Christians; Russian Christians and English Christians; French Christians and German Christians; but they are all of them swine. And he who wishes to imitate the Christians wishes to wallow with the swine in the mire.'

"'But, surely,' I said, in astonishment—for the Vali was generally polite—'surely your Highness does not mean to say that you think us all swine?'

"'Well,' he said, 'I was very young then, and my brain was full of nonsense, so I thought my father was a fool. But now that my own beard is getting grey, by God, I think that the old gentleman was right.'"

I am not sure that we must take the old Vali exactly at his word. Our experience in Algeria seems to prove that there are among the natives a small number of individuals who are quite ready to turn their back on Moslem civilisation and to become French citizens in the full sense of the word. But a policy cannot be based on exceptions. The dominant fact in Algeria, as well as in Turkey or in Egypt, is that not only the great mass of the population, but even the more or less educated upper classes, are unwilling to drop the laws and customs dictated by their faith and to adopt our Western ways. This does not mean, however, that nothing can be done, either to allow them to defend their interests or to bring them nearer to our own civilisation. As a matter of fact, it is that very middle course that the French Government are likely to follow.

It is not my intention to describe in detail the programme of reform which seems now to have been accepted by the colonists as well as by the unanimity of the French Parliament. It will be sufficient to say that already before the war an improvement in the condition of the natives appeared to all disinterested observers to be an imperative necessity. It is not that French rule has not already done much to better the general state of the Algerian natives. One or two facts will be more conclusive in this respect than all I could say. Out of 100,000 French ploughs which were used in Algeria in the year 1910, 34,420 were owned by the natives. To anyone acquainted with the difficulty of inducing an Eastern population to change its agricultural methods, this mere number will, I think, demonstrate that education of the native has been proceeded with in a rather satisfactory way. Another remarkable feature is the development, under the leadership of the French administration, of mutual benefit societies, entirely devoted to furthering native agriculture; the membership of these reached 540,000 in 1910, and they have spent millions during this war with the object of relieving the native farmers. Perhaps it will be considered equally significant that the wives of the native soldiers—of the Turcos—at the Front have received, since the outbreak of the war, exactly the same allowance as the wives of our men at home. There is no doubt, therefore, that French rule has been, on the whole, very beneficial to a population which up to 1830 had known nothing but the oppressive methods of the Turks. But, on the other hand, the same natives have certainly been labouring under a number of undue disabilities. While the French colonists were not only represented, since 1898, in two general assemblies called "Financial Delegations" and "Superior Council," which control the local budget, but were also sending six deputies and three senators to the French Parliament at home, the natives had only a small representation in the municipal and local bodies—a representation which, besides, was entirely under the thumb of the French Administration, which appointed, and is still appointing to-day, most of the native members. In the second place, although it is impossible to govern an Eastern population without applying to them a certain measure of autocratic rule, it cannot be denied that the French Administration had gone rather far in this respect, and was, for instance, making some abuse of a certain *right of internment or deportation* which allowed them to intern any native without judgment. Last, but not least, whilst equality in taxation, that very keystone of a sound colonial policy, has now been established both in Tunis and Morocco, no taxation was paid by the Europeans on their landed estates, while the natives were still paying the old taxes which were in force at the time of the Turks. No possible justification could obviously be found for this particular exemption of all the European owners. "The reason why they did not pay these taxes," as Lord Cromer once wrote of the Europeans in Egypt, "was because they did not like paying them." All these inequalities were already breeding much friction before the war; were they to survive, when the war is over, they would certainly lead to disastrous consequences.

Fortunately it has been now agreed that a reform at the same time—fiscal, judicial, and political—must be started without delay in

favour of the natives. The subject was debated somewhat hotly during the years which immediately preceded the war. In order to convince some of the colonists who believed quite honestly, I am sure, that advocates of reform were plotting their ruin, we had to quote the British precedents in Egypt and in India, and I am afraid I was personally bold enough to hide myself behind the authority of that great master, whose book on modern Egypt is to many of us a sort of Bible, Lord Cromer. I am happy to say common sense prevailed quite soon, and the reforms which were advocated began as early as January 1913. Although the survey of the whole land required for the equalisation of land taxes is not quite finished yet, it will certainly be completed before long, and in any case, as the principle of equality in taxation has now been accepted by the colonists themselves, the fiscal reform, the most vital of all, may be considered settled. A great improvement has already been brought about in the judicial condition of the natives by a law voted in July, 1914, which, among other things, suppressed in its old form the right of internment, and by a decree passed a little later, which exempted from the special penal code the middle and upper classes of the native population. Finally, the native representation has been somewhat bettered by enlarging both the number of electors and of the native representatives inside the local bodies. And this is only a beginning. It cannot be doubted any longer that both the local French opinion and Parliament at home will agree on further political reforms, the object of which will be to supply the natives with a complete separate representation inside the local assemblies, so as to enable them efficiently to voice their interests. Some go as far as to suggest already that the native electorate should be allowed to send to the home parliament its own representatives side by side with the members representing the French colonists. This last scheme, however, has not taken definite shape yet.

Let me now characterise more precisely in what direction this liberal native policy is moving. While there is no wish to further premature assimilation between the Mohammedan Algerians and French citizens, there is a very marked tendency not to draw a definite bar between the two races, but, on the contrary, to educate gradually the natives so as to bring them nearer to French civilisation. I believe there is a great difference in this respect between your policy in Egypt and ours in Algeria. So far as I can ascertain, the liberal disposition of the British mind has prevented you from trying to anglicise, so to speak, the Egyptian native. Our tendency, not only in Algeria, but in the whole of North Africa, is certainly to be more absorbing. This appears from the mere fact that all the primary schools we are setting up for the natives in any of these three countries are French schools in which the French language is the very first thing that is taught. The more or less conscious idea underlying such a system is that a moment may come in the distant future when the educated elements of the native race will detach themselves from their old Eastern world and become as completely a part of the French nation as the son of a Spanish immigrant. In other words, while trying, before all, to make the Mohammedan as happy as possible in his present condition as a subject, the new liberal policy which is certain to prevail tends to preparing these white Easterners for the day when they may be ready to become full citizens of the French democracy. I daresay this peculiarity of French policy is not altogether derived from our sociability, which is, at the same time, our great asset and the most deplorable of our weaknesses; but also arises from this grand conception I have tried to define to you, of a new France beyond the sea which is to be the future rock on which the nation will stand.

This does not mean, however, that we are blind to the difficulties of this somewhat romantic task. No European nation which attempts, according to its own traditions, to educate the native population while retaining its rights of sovereignty, can ignore the fact that education breeds discontent more often than affectionate feelings. There is at present no movement in any part of North Africa corresponding to the nationalist agitation in Egypt. We have no "Young Moroccans" yet, because Morocco is still in its infancy. Our "Young Algerians" and "Young Tunisians" have not exhibited, so far, that brilliant genius which makes some of the Egyptians so undesirable, both to their British rulers and to themselves. It is quite possible that, owing to the presence of a large European element, a nationalist agitation among the natives will always, in North Africa, be doomed to failure. But the future lies on the knees of the gods, and the agitating spirit, which has always been so conspicuous in North African populations, may give us one day much more trouble than w

expect. Knowing for my own part, as I do, the dispositions exhibited by some of the educated Kabyles, I should not be surprised at all if native unrest in Algeria were to take, sooner or later, the shape of a wild Socialistic propaganda. One thing at any rate is certain, the difficult experiment France is making along the range of the Atlas will only succeed if the general peace of this huge country is so well maintained that no spark will ever have a chance of lighting one of those fires which so easily spread through a hot-headed Eastern population. Of course, the present war has been somewhat reassuring in this respect, as, in spite of a few local disturbances, the whole population of Algeria and Tunis have remained distinctly loyal. But, as our French proverb says, one must not tempt the devil. The future of the whole French fabric in North Africa depends, therefore, upon the way in which we shall be able to maintain throughout North Africa the *Pax Gallica* which is replacing the *Pax Romana* of the past. This brings me to the second problem raised by the war—that of the diplomatic safety of the French African island.

It is indeed quite true to say that North Africa is an island. No such threat could easily be directed against it as was experienced by Egypt during a certain period of this war, owing to the existence of a common boundary between Egypt and Turkey. Suppose even that the worst should happen, and that Italy, instead of being our true friend, should become our enemy, the road of invasion which is left open on the Tripolitan border of Tunis would be rather easy to defend. As a matter of fact, no unpleasant surprises have come during this war to North Africa from outside. The only incidents worth mentioning are the incursions made in October, 1915, in the south of Tunis by some rebel Tripolitan tribes, which were quickly disposed of, and, further, the invasion by the Senoussis and Touaregs of the territories of the Sahara. This last trouble had not the slightest reaction on the internal state of Algeria, and has been well in hand since at the end of last year General Lapperine was put in command of all the troops operating in the Sahara region. But while the insular position of French North Africa makes it sufficiently safe as regards any danger coming from without, the same cannot be said of some of the dangers which the war has shown to exist owing to the presence inside the limits of North Africa of an important territory which absolutely escapes French control—*i.e.*, the Spanish zone of Northern Morocco.

Before I attempt to state the facts connected with this particular question, I feel it is necessary to say that I do not intend to criticise in the least the attitude of the Spanish Government, or to complain about a situation based on treaty rights which have been ratified by France herself, as well as by Spain and partly by Great Britain. My only object is to draw your attention to a condition of things which to many thinking Frenchmen is a matter of some concern.

It is only natural that a state of unrest which prevailed in Morocco when the war broke out should have become more acute as the result of the withdrawal of part of the French Expeditionary Force, which was wanted on the European Front. There is, therefore, nothing astonishing in the fact that the end of 1914 should have been somewhat critical. If it had not been for General Lyautey's remarkable ability we might have had more than one incident such as the local defeat a French column suffered near Khemifra on November 13th, 1914, which fortunately was made good by a successful counter-stroke. A general insurrection might easily have taken place, owing to the extraordinary fierceness of the tribes, had not the French Commander-in-Chief displayed at the same time much pluck and much political wisdom. Even after a number of severe lessons had taught the rebels that the war had not diminished the efficiency of French arms, a number of local fires went on, and are still going on, burning all along the Great Divide which separates Algeria from Morocco. Moreover, our old enemy, the ex-pretender Heiba, started, in the south, an agitation of his own, which was only repressed a short time ago, in March, 1917. The task which General Lyautey had before him was bound, in any case, to be a most difficult one, as he had to hold some of the roughest fighters of the whole African world with a mere handful of troops. This, by the way, will explain to those who are not acquainted with our Moroccan difficulties why French opinion entertains such a well-deserved regard for the man who managed to maintain, and even to improve, French rule on the Moroccan soil during one of the most critical periods of our history.

Moroccan unrest during the war would, however, have been, so to speak, normal, if the situation had not been complicated by the activities of the Germans established on Spanish

territory. Although the German war organisation extended well over the whole world, I doubt if their plans had been anywhere as carefully prepared as in this particular spot. What they intended to do was not only to generalise the unrest in Morocco itself, but to stir up an insurrection of the natives throughout North Africa so as to prevent France from bringing over a single man and a single gun. With this object in view, they had set up, both in Spanish Morocco and in Spain itself, a complete organisation the details of which are public matter. There was, for instance, in Madrid a German military attaché, named Colonel Kalle, who is said to have had at his disposal a monthly budget of 2,000,000 pesetas with which to support the armies, or Harkas, of rebels which were to invade French Morocco from the Spanish zone. Another active gentleman was the German Consul in Tetuan, the capital of Spanish Morocco, Herr Zechlin, who with the help of a Bavarian officer openly tried to provoke desertions among the French Foreign Legion and to equip with rifles and machine-guns all the Harkas raised against the French. These men have had from the first a numerous staff of German agents. While Colonel Kalle was being helped in Madrid by a Dr. Graussmann and by a Professor of Arabic, named Braun, two of the famous Mannesmann brothers were operating in Spanish Morocco itself, and were assisted by such men as a certain engineer named Far and a late German Consular agent named Foch, who were visiting the whole interior of the Rif in order to proclaim the Holy War. All these men were, of course, well supplied, not only with money, but with news, and found marvellous facilities for organising the smuggling of arms, which in that part of the world is a sort of traditional industry.

I am happy to say that they failed in their main attempt to foment in North Africa a general uprising. It would be, however, a mistake to believe that they have not succeeded in making things very unpleasant for us. One of their first schemes consisted in inducing Moulay Hafid, the ex-Sultan, to leave Tangiers, from where, owing to the special situation of the town, the French and British agents had managed to expel all the Germans, and to put himself at the head of a big army which was to restore him to the throne of his ancestors. Hafid consented to come to Spain, but his Oriental wisdom prevented him from accepting the latter part of the German offer; so that up to the present day he has managed to use German money for his own private enjoyment. The German agents then resorted to another scheme. They dug out a certain Abd el Malek, a grandson of the famous Abd el Khader, who was at one time the most dangerous enemy of France in Algeria. They put him at the head of a fairly considerable army, which tried to invade French Morocco at the end of 1915, with the object of joining hands with the rebels of the central Atlas region and of putting the whole Moroccan agitation under one single German control. The swift action taken in January, 1916, by one of General Lyautey's columns put a temporary end to this cunning enterprise. Abd el Malek had to take to flight, and would have been a lost man if it were possible in a country like this to crush anybody once and for ever. Since then, although he has not been able to achieve much, he has all the same found another army with the help of his German friends, and a new attack on his part is constantly expected by the French command. The inventive genius of the Germans did not stop at that. They found last year a much more formidable ally in the person of the famous Raissuli, the principal native chief of Spanish Morocco. This King of the Mountains has not only managed to raise an army of several thousand men, but he has been supplied also with the most modern rifles, with machine-guns, and even with guns well attended by European gunners. Now the intentions of Raissuli cannot be ignored, as he has for several months been issuing proclamations well inside French Morocco, by which he calls upon the tribes to join him in a crusade against the main enemy of Islam—France. An attack on his part on the town of Uezzan, the French place nearest to the Spanish zone, has already been expected several times, and there is no doubt that he will avail himself of the very first opportunity for launching an enterprise which would certainly be more serious than the first venture of poor Abd el Malek.

These various evils must not be exaggerated. On the whole, the military situation in Morocco is better at present than it ever was since the outbreak of the war, and there is little doubt that should Raissuli or Abd el Malek try to cross the Spanish border they would meet with a very warm reception indeed. Nevertheless, the awkwardness of the situation will be very great as long as the war lasts. Owing to the fact that, with the exception of Tangiers, the whole Spanish zone has been converted into a base for active German propaganda, a constant

threat is being directed against French North Africa which France has no means of removing once and for all. It is exactly as if a man had a fire perpetually burning in a part of his house, with the possibility of seeing that fire suddenly spread to the other parts of the building. And the most paradoxical side of it all is that we are prevented by the existing treaties from trying to extinguish this fire before it produces a catastrophe. The Raissuli danger, for instance, would not last very long if a French column were allowed to cross the border and teach him the lesson he deserves. But we are not allowed to extend our action beyond the line drawn by the last Franco-Spanish Treaty of 1912. More than that, suppose a so-called Harka should invade our territory, we should not be allowed to pursue it, in the course of its retreat, across the same border. The case has happened already once—in 1913, when General Gouraud, after repelling an incursion of this kind, had suddenly to stop and present arms at the very moment when he was on the point of capturing the retreating enemy. I need not describe the strain which circumstances such as these impose on the few men who are guarding the northern border of French Morocco.

Nor is this unpleasant condition of things going to end with the war. What we have experienced in Morocco during the last three years cannot leave us under any delusion in this respect. Of course, there will be after this war no such danger of a general insurrection taking place. At the same time the complete pacification of that part of North Africa will, under the present system, remain almost an impossibility. It cannot be expected that the intrigues of the German agents of Spanish Morocco will end with the war; they will very likely go on using Spanish Morocco as a base for keeping up an agitation which will appear to them as a necessary revenge for their disappointed hopes. The smuggling of arms, at any rate, will go on for ever, and everybody knows that so long as disarmament cannot be enforced no permanent peace can be established among wild Eastern peoples. The very connection between Morocco and Algeria is itself in danger of remaining forever a very precarious one, for the only valley which cuts through the range of the Atlas is the Valley of Taza, which lies close to the Spanish border. The railway, which is already being built between Fez and the Algerian border, will be always exposed to be cut by temporary raids of the Rif tribes which we have no means of punishing. In one word, the *Pax Gallica* of which I have spoken will for this reason remain for a long time a mere dream,

It can truly be said, therefore, that the war has revealed the inconveniences of the present diplomatic situation of North African France. It is not for me to say what the remedy should be. What has been called the Moroccan tangle has already given much trouble to European diplomatists: let them deal themselves with the difficulties they have often wantonly created in their ignorance of the real conditions of that country. Moreover, I need not add that no Frenchman contemplates a departure which would not be acceptable to Spain. But it will be sufficient, I believe, to call, for the present, the attention of our British friends to the awkwardness of our diplomatic position such as it is now.

Let me say one more thing in conclusion. Whatever solution may be suggested of the difficulties which are still hampering the development of French North Africa, there is one dominant fact which stands out among all the others, and this is, that British and French rule in those parts of the world will stand or fall together. There is not one Frenchman who does not realise to-day that the maintenance of British power in Egypt is essential for the safety of our North African Empire. The reverse is certainly true as well. I do not think I am betraying any secrets if I say that one of the main anxieties of the men who are responsible for the administration of Egypt arose, at the outset of the war, from the possibility of some form of general unrest taking place in French North Africa. Subsequent events have demonstrated that these fears, if they were ever seriously entertained, were devoid of foundation. French North Africa will come out of the ordeal of the war as victoriously as Egypt or India, and nothing could have proved more conclusively that French and British rule in these various countries has come to stay. If, however, we are to develop successfully these Eastern countries, each of us according to his own genius, I believe we must support each other in the future even more firmly than we have done in the recent past. For my own part, I cannot help believing that this special link between France and Great Britain is one of those which ought to be made closer and closer every day. So far as France is concerned, this association is a matter of vital importance. The ancients said the Giant Atlas was supporting the

heavens. It is at any rate supporting the future of France. Nothing, therefore, has a greater bearing on the destinies of the French democracy than the close alliance which I hope will always unite the African Empires of both nations, already united in their effort for the liberation of Europe.

(The discussion on the paper will be published next week.)

IRRIGATION IN THE WESTERN UNITED STATES.

An article, published in the annual report of the Smithsonian Institution, on "Progress in Reclamation of Arid Lands in the Western United States," by Mr. J. B. Beadle, of the U.S. Reclamation Service, contains some interesting information of the great irrigation works which have been carried out by that Department. As a result of their activity since 1902, a million and a half acres can now be supplied with water through the Government systems, and half of this area is actually producing crops totalling nearly $20,000,000 in yearly value. In fact, the annual product from the irrigated lands already exceeds that of a number of the smaller States.

The principal crop on the irrigated areas is alfalfa. It occupies nearly half the cropped acreage, and yields over one-third of the total crop value. Once established, it is a hardy plant, and continues almost indefinitely to furnish good annual yields without re-seeding. It gives several crops each year. It is a legume with the peculiar power of drawing from the atmosphere the nitrogen in which the soils of the arid region are often deficient, and leaves behind more than it found of this most valuable of plant requirements. It is the deepest of subsoilers, its roots penetrating to a remarkable depth for the other essential elements of plant growth, and improving the physical condition of the soil.

A great variety of other crops are grown on the Government projects—hays, cereals, fruit, sugar beet, and cotton, as well as garden products. Barley is the leading cereal. Beet-sugar factories have been established on some of the larger projects, contracting with farmers for a profitable crop on a large area. Cotton has furnished an industry of some importance on the southern projects, but this has been set back by the adverse conditions following the outbreak of war in Europe. Fruit-growing is making steady, if slow, progress, and has flourished on some of the lands peculiarly suited to it. Thus the Sunnyside Unit, in Washington, is the home of the famous Yakima Valley apples, and in 1914 produced over a million dollars' worth of fruit.

The article gives particulars of the twenty-three undertakings which have been carried through to completion. In the first of these, the Salt River project in Arizona, the flow of the river has been utilised to irrigate 200,000 acres of land surrounding the State capital. Storage is provided about 80 miles above Phœnix by the famous Roosevelt Dam, a rubble masonry arch in the river canyon, 280 ft. in maximum height and 1,125 ft. along the crest. This gives a reservoir capacity of 1,367,300 acre-feet, or over 400,000,000,000 gallons. From Roosevelt the stored water is passed 40 miles down the river channel to Granite Reef, where the diversion dam turns it into canal systems north and south of that stream. Over 700 miles of main canals and laterals have been excavated to distribute the water to the farmers. The opportunities for hydroelectric development created by the construction of the irrigation works have been utilised by building power-plants at the base of Roosevelt Dam and at several points in the canal system where necessary drops afford good heads. Transmission lines have been built, delivering power to the several towns on the project, including the city of Phœnix, where it is used for lighting and manufacturing, and to mining industries, to which the surplus is sold. In 1915 about 190,000 acres were irrigated under this system.

The Laguna Dam, constructed above Yuma, Arizona, measures 4,780 ft. between abutments, with a maximum height of 40 ft. This turns the water into canals on both sides of the river for irrigation in Arizona and California. The main canal is on the California side, and after covering lands on that side crosses the river by means of an inverted syphon. This structure, completed in 1912, consists of two circular concrete shafts connected by a circular concrete-lined tunnel, with an internal diameter of 14 ft., and 930 ft. long. The syphon delivers water to the canal system covering the largest portion of the project in the Yuma Valley. At present the system is capable of watering 70,000 acres. This figure will be extended to 90,000, and an additional 40,000 acres may be reached by pumping.

One of the largest projects nearly completed is the Boise in Idaho. The reservoir is formed by the Arrowrock Dam, the highest in the world, a rubble concrete arch rising 350 ft. above the lowest point of the base, and measuring 1,075 ft. along the crest. The inaccessibility of this site and the large amount of material to be hauled for the construction, made it economical to build a seventeen-mile railroad from Barberton. About 12 miles below Arrowrock and 8 miles above Boise is the diversion dam of the project, turning the water into the canal system, which includes a main canal carrying the water to the Deer Flat Reservoir, another storage basin formed by

several large earth embankments, closing a natural depression some distance from the river.

In addition to the Arrowrock Dam, the principal work since 1910 has been the completion of the distribution system, comprising 1,000 miles of canal and 12,000 structures. Nearly 10,000 acres of the Boise project are now in crops, and the annual production already exceeds a million dollars. Alfalfa, clover, cereals, and potatoes are the leading products.

SUMAC CULTIVATION IN SICILY.

There are two species of sumac grown in Sicily, the wild and the cultivated. The wild variety has a short stalk, small leaves attached two by two to a short stem, the leaves sparsely covered with a white fuzz on both sides, the stem with no small leaves near its base. The cultivated plant (*Rhus coriaria*) has a longer stem than the wild, its leaves are larger, and are covered with fuzz only on the lower side, and the stem of the leaf has small leaves along its entire length.

Sumac requires a dry, loose soil. The best is a clay soil with lime and silica mixed. It does not grow well in damp, compact ground. The soil may be rich or poor, so long as it is dry. However, the best sumac is grown on soil of volcanic origin. This soil, together with much heat, produces the greatest amount of tannin. In Sicily sumac is grown at all elevations up to 2,000 ft.

It appears from a report by the United States Consul at Palermo that sumac is planted in furrows 8 in. wide, 6 in. deep, and 27 in. apart, the plants being placed 27 in. apart in the furrow. The sprouts should be taken from a full-grown plant and care exercised that the roots are entire. They must be a year old. The planting is usually done in December or January. The ground should be ploughed twice about four to six months previous to the planting. The plants should be cut down to within 6 in. of the ground.

During the first year the ground should be spaded six times—immediately after the planting, in February, April, May, June, and September. The first three spadings should be deep, the others only light. During the second year there should be three spadings—in January, March, and May. In December the little shoots that have appeared at the foot of the plant should be cut off. Sumac should be cultivated alone. The shade of trees retards development and reduces the amount of tannin.

The gathering of the leaves takes place when they commence to turn yellow, usually in July and August. Some growers cut the twigs off near the stem and send them in this form to the thrashing floor, where the leaves are separated from the stems by heating or by thrashing with horses. However, this is not a desirable method, as it does not produce a good quality. The best method is to gather the crop in three periods. First, the leaves near the stalk up to about the middle of the limb are gathered. Twenty or twenty-five days later half of the remaining leaves are gathered. A few days after this the ends of the twigs are cut off. This method gives two or three qualities of sumac, but, as it requires a great deal of time and labour, the usual method is to cut off the whole plant near the ground. The twigs are piled on a floor, and are turned three or four times a day with a fork.

After the leaves are separated from the wood they are taken to the mill, where they are packed in bales or ground for shipment. There is no treatment at the mill which affects the amount of tannin contained in the sumac.

THE CO-OPERATIVE SALE OF WOOL IN CANADA.

The enthusiastic support given by the Canadian Government to the development of co-operation within its territory is well known, as are the excellent results already obtained by the organising work it has inspired.

Wool production and the trade in wool afford another example of the usefulness of co-operation to farmers. An effort, which had its co-ordinated beginning only three years ago, has given rise to a new situation full of promise for the future, and already of great benefit to the producers as well as to the wool industry.

The Central Government's propaganda and that of the Provincial Governments in favour of the co-operative sale of wool has been fruitful more or less everywhere, although in some provinces this method of sale is still in its initial period.

Most farmers having a flock of sheep were formerly at the mercy of wool merchants, who wandered about the country from farm to farm making offers which the producer was in most cases obliged to accept, however little he liked them, unless he wished not to market his produce. The prices paid on the spot by these dealers or their agents were naturally much lower than those obtained in the large markets, and the small sheep-farmer was thus deprived of the greater part of the profit which ought to have accrued to him. It followed that he almost ceased to take interest in the improvement of his flock, and was at no pains to inform himself as to the condition and the needs of the wool trade.

The organisation of the co-operative sale of wool, which is described in the *International Review of Agricultural Economics*, published by the International Institute of Agriculture, did away with these disadvantages. In the measure of its still limited adoption it has ensured to farmers owning sheep a just price for their produce. It has, in the first place, eliminated the middleman, either because—as is notably the case in Saskatchewan and Manitoba—the Department of Agriculture undertakes to sell the wool sent to it by producers, or because the responsibility of marketing the wool

of members has been assumed by a large association of sheep-farmers. The latter expedient is employed in Alberta, Quebec, and Prince Edward Island. Centralisation has solved the problem of transport, complete car-loads of wool being made up, and a considerable economy has thus been effected.

But it soon became apparent that for the remunerative marketing of wool there was another necessary condition. Co-operative selling of wool, without preliminary grading of its different classes, is an improvement on individual selling, but can be of only limited benefit to sheep-farmers. The Dominion Department of Agriculture made a new step forward possible when it placed expert graders freely at the disposal of the Provincial Governments who asked for them. Thus a uniform system of grading has been established in various Canadian provinces, and has allowed a firm basis to be given to the value of wool.

The scientific grading by experts has further enabled those numerous improvements to be ascertained which it was necessary to introduce into the methods of shearing and of preserving and packing fleeces in order entirely to obviate their deterioration. Carefully drawn-up rules have been communicated to the farmers as being the *sine quâ non* of the sale of their wool by the Department of Agriculture. Short courses of instruction in the rural centres, lectures and practical demonstrations —organised or provided by the Department of Agriculture—have produced a tendency towards more scientific sheep-farming. Farmers have become aware of the importance of selecting the breed of their sheep with a view to wool production, and they attempt to remedy the defects of their wool. Thus the flocks of Canada increase while their intrinsic value is augmented.

Such are the general results of Government intervention in favour of the co-operative sale and the grading of Canadian wool.

Altogether, according to the official Preliminary Report of Wool Grading Operations in 1916, the Government experts, who have worked in all the provinces of Canada, have graded 140,178 fleeces, weighing 1,004,512 pounds and produced on the farms.

The importance of this form of co-operation, now in course of development, cannot be too much emphasised, especially at the present time. Facts concerning it are instructive, because it is fitted both considerably to increase the production of wool and to improve its quality, and might well be adopted in many countries and contribute to augmenting their wealth in sheep.

OBITUARY.

Sir Richard Burbidge, Bt.—Sir Richard Burbidge died suddenly from heart failure at his residence in Hans Mansions, S.W., on May 31st.

He was born at South Wraxall, Wilts, in 1847. After serving his apprenticeship with Mr. Jonathan Puckridge, a tea and colonial merchant of Oxford Street, he started business on his own account at the age of nineteen in wines, groceries, and provisions. Fourteen years later he was appointed general superintendent of the Army and Navy Auxiliary; in 1882 he became general manager of William Whiteley's; and in 1891 he went to Harrod's Stores, which had just been converted into a limited liability company. Some idea of the great development of the business under his guidance may be gathered from the fact that when he joined the firm the employees numbered 200, and the year's profits were £16,071; to-day the staff numbers 6,600, while 2,000 men and women on the firm's list are serving the country as sailors, soldiers, or nurses; and in 1909, when Harrod's celebrated their Diamond Jubilee, the year's profits had risen to £198,322.

In addition to his business activities, Sir Richard Burbidge found time to do a great deal of public work. He was a member of the Munitions Advisory Committee, of the Executive and General Purposes Committee of the Board of Control of Regimental Institutes; of Sir E. Ward's Committee on Voluntary Organisation; and of the Home Office Shop Committee. He was chairman of the Committee on the Royal Aircraft Factory; a trustee of the Crystal Palace, and of the Early Closing Association and Provident Society; and a member of the Training Sailors' Executive Committee, and of the Committees of Queen Alexandra's Field Force Fund and the Anglo-Russian Hospital.

In recognition of his public services Sir Richard Burbidge was created a baronet in 1916. He became a member of the Royal Society of Arts in 1904.

Lieut.-Colonel Francis William Panzera, C.M.G.—Lieut.-Colonel Francis William Panzera died suddenly on the 4th inst., while inspecting one of the compounds of the Knockaloe Enemy Alien Camp, Isle of Man, of which he was Commandant.

He was born in 1851. After serving some years with the Royal and Militia Artillery, he was appointed in 1888 Acting Engineer with the Royal Engineers, to raise, organise and train the Harwich Militia Division and First Class Army Reserve (Submarine Miners). In 1892 he was nominated by the War Office to serve under the Colonial Office in South Africa, and the following year he was appointed Government Engineer Officer and Superintendent of Public Works, Bechuanaland. In the Matabele War, 1893–4, he commanded the Imperial base at Macloutsie, and the southern line of communications under Colonel Goold-Adams, and for his services on this occasion he was promoted Major, Reserve of Officers, and

received a medal. After this he was appointed Secretary to the Khama Southern Boundary Commission, 1894; Imperial Government Engineer and Representative, Vryburg-Palapye Section of the Rhodesia Railways, 1894; Expert to the Treasury for the preparation of maps, etc., for the Jameson trial, 1896; British Member and President of the British-Transvaal Joint Boundary Commission, 1897; and Special Commissioner in Ngamiland, 1898–9. He served throughout the South African War from 1899–1902, commanding the artillery at the defence of Mafeking. He was twice mentioned in despatches, received the Queen's medal with two clasps, the King's medal with two bars, and was promoted Lieut.-Colonel, Reserve of Officers. He was Special Commissioner for Administering Oaths of Allegiance, 1901–2; in 1904 he became Acting-Resident Commissioner for the Bechuanaland Protectorate, and Resident Commissioner in 1907.

He was elected a member of the Royal Society of Arts in 1906.

GENERAL NOTES.

The Growing of Medicinal Plants.—After commenting on the paper on "Herb-growing in the British Empire," recently read before the Royal Society of Arts by Mr. J. C. Shenstone (see *Journal* of May 4th, 1917, page 445), the *Lancet* says: "Undoubtedly very many vegetable drugs have been discarded since 1790. Remembering this, but knowing also that it has been prudence and not prejudice which has dictated the scientific attitude, we fear that an attempt to revive interest in home-grown pharmaceutical plants is doomed largely to disappointment. They have been tried and found wanting. Modern tendencies amongst medical men point to a form of treatment based upon an intimate knowledge of pharmacology, and the vegetable drugs which are retained in most instances have had to justify their existence as remedies by the presence of some definite alkaloid or active principle. If the activities of the National Herb-Growing Association are limited to the encouragement of an increased supply of herbs possessing alkaloids or active principles, it is possible that a glut in the market may be produced speedily. On the other hand, it is very probable that, owing to improper methods of cultivation, a large amount of trouble will be expended without any corresponding advantage, as it is well known that medicinal plants require many peculiar conditions of soil and climate before they can attain the standard required by authority. With adequate care and knowledge these difficulties may be overcome, but the conditions cannot be met by enthusiasm alone. They demand special training and considerable expenditure, facts which were recognised by Mr. Shenstone in his lecture, in which he pleads for a Government Department entrusted with funds. We would not for a moment be found damping down the fires of a well-intentioned energy, but . . . both money and expert knowledge are called for if the result of the growing of medicinal plants in this country is to be relative to the labour put forth."

Paper Manufacture in South Australia.—A Bulletin issued by the South Australian Department of Chemistry gives details of an investigation into the prospects of establishing a paper-making industry in South Australia. The probability of a famine in certain classes of paper, owing to the dislocation of trade and transport caused by the war, has led to this investigation being undertaken. As indicative of the demand which exists in South Australia, it is stated that the total value of paper imported into the State in 1913 amounted to £136,943, while that of millboard, strawboard, etc., was £9,364. The opinion is expressed that the principal material to be used must be straw, of which a quantity, amounting to half a million tons, is available annually within a hundred mile radius of the principal seaport. From the results of preliminary tests, there seems to be little doubt that South Australian straw will yield satisfactory pulp for the production of paper of ordinary qualities. As a result of the investigation, it is stated that the prospects of establishing a paper-making industry in the State on the lines set out in the Bulletin appear to be sufficiently attractive to make the subject worthy of further attention.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 11...Brewing, Institute of (London Section), at the Imperial Hotel, Russell-square, W.C., 7.30 p.m. Mr. C. A. Mitchell "Notes on the Manufacture of Vinegar."

Wednesday, June 13...Aëronautical Society, at the Grafton Galleries, Grafton-street, W., 8 p.m. Col. M. O'Gorman, "Foresight in Aeronautics: Technical, Political and Financial." (Wilbur Wright Memorial Lecture.)

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Rev. W. T. Pilter, "The Manna of the Israelites."

Thursday, June 14...Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Friday, June 15...Mining Engineers, Institution of, at the Geological Society, Burlington House, W., 11 a.m. 1. Dr. J. S. Haldane, "The Spontaneous Firing of Coal." 2. Mr. E. Bury, "The Bye-product Coking Process: its History, Development, and Application." 3. Mr. W. Maurice, "Acetylene Mine Lamps." Discussion on the following papers:— 4. Mr. J. I. Graham, (a) "The Permeability of Coal to Air or Gas, and the Solubilities of Different Gases in Coal." (b) "The Absorption of Oxygen by Coal. Part X.—The Formation of Water in the Oxidation of Coal." 5. Mr. D. Ferguson, "The Form and Structure of the Coalfields of Scotland."

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FRIDAY, JUNE 15, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Sixty-third Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Fellows, will be held, in accordance with the By-Laws, on Wednesday, June 27th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary*.

DESIGNS FOR MEDALS.

At the request of the Executive Committee of the Exhibition of Medallic Art lately opened in London, the Council of the Society placed three Silver Medals at the disposal of the Committee for awards for Medal Designs. These were offered for the best Portrait, the best Allegorical or Symbolical Design, and for the best Historical Design.

They have been awarded as follows by the Committee of the Exhibition, and the awards have been confirmed by the Council:—

For the best portrait, to Lieut. S. W. Carline, R.F.C., for a portrait medal of Miss H. Carline and G. R. Carline.

For the best allegorical or symbolical design, to John Pinches for his Music prize medal, "Orpheus."

For the best historical design, to Ernest G. Gillick for his designs for the reverses of the Polar, Tibet, and Long Service naval medals for the Royal Mint.

EXAMINATIONS.

The results of the Advanced and Intermediate Examinations (Stages III. and II.), held from March 26th to April 2nd last, were sent to the centres concerned on the 7th inst. It is hoped to send out the results of the Elementary Stage towards the end of this month.

The time tables for the 1918 examinations have also been sent to all centres. The first examination will commence on Monday, March 18th, and finish on Monday, March 25th. The second commences on Monday, May 6th, and finishes on Wednesday, May 15th.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

Report of the Discussion on the paper on—

PROBLEMS OF FRENCH NORTH AFRICA.

By CAPTAIN PHILIPPE MILLET,
Colonial Editor of *Le Temps*.

(*Continued from p.* 525 *of the* "*Journal*" *of June 8th*, 1917.)

THE CHAIRMAN (The Right Hon. Lord Blyth) said he was sure that he might, in their name as well as his own, thank Captain Millet very heartily for the masterly way in which he had placed so much useful information before them. This was the second paper in our language read before the Society's Colonial Section this session by a member of an Allied country. The other was contributed by Monsieur Max Horn, and dealt with the economic development of the Belgian Congo. It would be a good thing if, after the war, some Englishmen were to visit Paris and Brussels and address societies there in the French language. The Chairman then read the following letter, which had been received by the Society from Sir H. H. Johnston:—

"But for local duties and the much-restricted local railway service, I should have desired to attend the lecture by Captain Philippe Millet, if only to give testimony to the excellent and decisive work of his father—Monsieur René Millet—in the Regency of Tunis. I served as

British Consul-General in that French Protectorate when the main lines of French policy were being laid down by the lecturer's father. I have rendered homage to this remarkable piece of statecraft in my 'History of the Colonisation of Africa.' It is sufficient to say that it marked the beginning of a new epoch in French Imperial administration, and served as the basis for the new French policy in Morocco. How sound a policy it was has been shown by the contentment of Tunis and the loyalty of Morocco to France throughout this terrible struggle with Germany. France in North Africa is resuming the work of Rome which was interrupted by the Vandals—who came from Prussia—and by the Arabs, who had not then learnt the wisdom of the Greeks. When Berber civilisation had begun to approximate Northern Africa with *renaissant* Europe, it was overthrown and ruined by Turkish pirates. France's great achievement in the nineteenth century was the release of North Africa from the Turk. Her work of the twentieth century will be the forming of North African nations which shall reach a degree of firmly based prosperity and enlightenment that surpassed the most liberal intentions of ancient Rome."

Most of those who had heard or would read Captain Millet's admirable paper, Lord Blyth continued, would have an increased desire to visit that attractive part of the world. Any present who, like himself, had already seen something of French North Africa, would have followed the paper with heightened enjoyment. When he was staying with some members of his family in the South of France in 1904 he met at Marseilles an old French friend, who begged that they should pay a visit to North Africa instead of remaining in the Riviera. On the following day they found themselves *en route* for Tunis. They were not enamoured with the French steamer which carried them across the Mediterranean and which suggested that the French had much to learn from us in shipbuilding, but Tunis was delightful, and they came to the conclusion that the French were at least our equals as colonisers. They were much interested in the fact that John Howard Payne, author of "Home, Sweet Home," so dear to every Englishman, spent the greater part of his life in Tunis, where he was American Consul-General, and although his tombstone was still to be seen in the churchyard, his remains were, thirty years after his death, taken to his native Washington. He (Lord Blyth) was much impressed in every part of Tunisia and Algeria by the magnificence of the roads. The Code of Napoleon having been extended to these Colonies, one could have almost thought oneself still in France. In motoring over the well-macadamised roads, at every turn they found signposts indicating the name of the towns or communes and distances from each other, clearly showing that these French Colonies enjoy all these advanced methods of civilisation. He was particularly interested in the viticulture of the country, which was only introduced into Algeria on a large scale after the appearance of phylloxera in France. The nature of the soil was such that, although little known in England, some of the best natural wines had been produced in enormous quantities to make up for the shortage of the national beverage in France. Wherever the eye turned, flowers and fruit appeared to gush from the earth, as Lord Byron said of Morocco, and there could be little doubt that no nation had such valuable Colonies as France had to-day in these North African territories, with the double advantage they had in being so near to their Mother Country. Might God forbid that Turkey or Germany should be in possession of any part of Africa again. Thus, with Egypt permanently in our hands, and Tunisia and Algeria in those of out trusted Ally, the progress of these vast fertile territories of North Africa might in the future be confidently assured, not only for the benefit of England and France, but for the whole human race.

MR. HAROLD COX said the author had covered in his paper a multitude of fields, both diplomatic and racial, and the main impression left upon his mind in regard to the diplomatic scope of the paper was the necessity of beating our present enemies completely, otherwise we could never be sure where their mischievous machinations might not crop up again. Captain Millet had also touched on the rather delicate point of the relationship of Spain, through Morocco, to France's Colonies. He confessed he had no suggestion to make as to how that very difficult problem might be settled. It was unfortunate that Spain had not yet decided to be one of the British Allies. Looking to the future rather than to the present, the part of the paper which interested him most was the author's description of the great racial and religious difficulties which affected the Colony of Algeria, and also Tunis to a lesser extent. His mind naturally went back first of all to the problems connected with India, and he thought those present with Indian experience would agree with him that those problems were very different. To begin with, there was not in India a very big English colony, as there was a big French colony in Algeria. The Englishmen in India were numerically an insignificant fraction of the population. Again, in India there was a tremendous variety of races and two great varieties of religion; whereas the natives of Algeria consisted mainly of one race with only one religion—the Mohammedan religion. Therefore, the Indian parallel was not at all close, and might be left out of consideration. The Egyptian parallel was much nearer, but he doubted whether there would ever be a very large English

colony in Egypt as there was a large French colony in Algeria. The author therefore suggested—he thought with a good deal of wisdom—that perhaps the nearest parallel was Ireland, because going back a few centuries it would be found that exactly the same thing was then happening in Ireland as was happening to-day in Algeria—*i.e.*, Englishmen with a certain number of Scotsmen were planting great colonies in Ireland, and the descendants of those colonists, deliberately planted in Ireland, constituted what was long known as the English garrison, just as the French colonists in Algeria were the French garrison. The parallel was fairly close in that respect. The opposition of religions also existed. Ireland, generally speaking, was Roman Catholic and England was Protestant; while in Algeria the native population was Mohammedan and most of the French settlers might, he presumed, be called Roman Catholics. This country had been more or less worried with the Irish problem for seven hundred years, and a solution did not yet seem to be near; and he hoped the author would not think him too pessimistic if he suggested that the French would not solve the Algerian problem in a very brief space of time. Where differences of race accentuated by differences of religion existed, a final solution was not easily arrived at. Certainly education did not bring the solution nearer, because he believed education in India had rather tended to widen the gulf between Englishmen and Indians. The same thing had occurred in Egypt, and he should not be at all surprised if education did not have the same effect in Algeria. Prosperity did not narrow the gulf; on the contrary, it tended to widen it. Going back to Ireland, nothing could be more striking than its extraordinary prosperity at the present time. Ireland had been gaining enormously in prosperity during the last twenty years — since the war began her prosperity had gone up by leaps and bounds; but there was no sign of increased content. Therefore neither prosperity nor education would solve the eternal racial and religious problem. He thought, however, it was possible to get nearer a solution by following the lines which the author indicated were being carried out in Algeria—namely, by the removal of race privilege, because where privilege occurred a constant source of irritation existed. He believed that what all human beings desired, whatever their race or caste or creed, was equality of justice. The author had told an Oriental story of fairly modern date. He (the speaker) desired to tell a very old story of a certain Indian Raja who, when he ascended the throne, was very anxious indeed to do the best for his people. In order to get advice as to what he should do for the happiness of his kingdom he summoned a great durbar, which all the nobles and people were invited to attend. Some of them said that he should dig wells so that the people might have water for their fields in the dry season; others said that he should make roads; others that he should plant trees so that the people might have shelter from the noonday heat; others even suggested education. But, finally, an old peasant in very poor clothes, who, as he entered the assembly and stood before the Raja, drew himself up to his full height, said: "O king, if you wish your people to be happy and contented, see that justice be equal for all."

Mr. A. Yusuf Ali, I.C.S. (retd.), desired, in the first place, completely to associate himself with the remarks made by Mr. Harold Cox as to the excellence of the paper. The French clarity of style, combined with the logical arrangement of the subject, had presented a picture of North Africa which would no doubt in the minds of many stir up a desire to know the country better. He could not help thinking that Mr. Cox was rather pessimistic when, after detailing the various unsuccessful methods of producing contentment, he went on to suggest one that he thought was efficacious—*i.e.*, equal justice and the abolition of privilege. Comparisons were generally considered to be odious, and he did not for a moment wish to make a comparison between the French administration of North Africa and the British administration of India, but he thought it was legitimate to mention facts about a country he (the speaker) knew well to a person who knew another country equally well. He felt, when he heard the author's remarks to the effect that it was extremely difficult to understand the Mussulmans, or his reference to the "ominous" question of how to make Mohammedans live in peace side by side with Christians, that the conditions in British India were very different indeed from those in North Africa. For one thing, the question of the Mohammedans was not an "ominous" question in India, and for another he thought it might be said that a successful solution had been found to the problem of how to make the Mohammedans live in peace side by side, not only with Christians, but with their Hindu fellow countrymen. He did not claim any special superiority for the Mohammedans or any other particular people of India, but he thought he was justified in placing before the author the view that hitherto in the British Empire, even though sometimes actual practice had lagged behind the ideal, the ideal had been to establish a system which should be as far as possible free from privilege or from invidious distinctions. He understood from the paper that the author approved of that principle. He also gathered that a commencement had been made in putting into practice in North Africa the principle which he approved, and he was quite sure that when that principle was completely carried out it would follow that any country in the position of North Africa must begin to assimilate more and more the culture

of Europe, not only to the advantage of itself, but of the world at large. He desired to be permitted to make a few remarks on the position of Islam *vis-à-vis* of the world at large. Islam had been very much misunderstood. The author had in one or two places used phrases which implied that Islam and progress were incompatible. He asked anyone reading history to picture to himself the world as it existed in the ninth century of the Christian era—the third century of Islam. An astronomer in Bagdad was then able to measure latitudes and longitudes. Ambassadors from the Christian capital of Byzantium had actually to be persuaded to recognise that science was a more useful subject of study than theology. In the eleventh century the progress of the exact and applied sciences depended upon the researches of Moslems like Al-Hazen. He asked those present to picture to themselves the surprise with which the Mohammedans of Bagdad might have met those people from Europe, who were not as well civilised at that time as the Mohammedan nations of the Middle East. If any Mohammedan had at that date said, as in fact some of them did say, that it was impossible to bring either Europe or Christians into conformity with "modern progress," they would agree that it would have been an unjust estimate. Apply that in a converse way. Islam so far had had 1,300 years of history, and he did not think that any fair-minded person would say, in view of the first 1,300 years of Christian history, that a proposition so universally put as that Islam was inconsistent with progress could be maintained. As a proof that that was not merely an opinion, he asked his hearers to consider the sixty-six or sixty-eight millions of Mussulmans in India, among whom were educated men who would take rank with educated men in any Universities in Europe or America. They possessed thinkers, poets, administrators and jurists—men who could see the difference between progress and civilisation on the one hand, and what passed as such in certain circles on the other. It was well known that the Mohammedan in India could hold his own with any people in the world. In his opinion, therefore, it was not correct to put any necessary opposition between European civilisation and the civilisation of Islam. The question remained whether the North African races were of the same stuff as the races of other parts of the world. The author had referred to the Kabyles and the Berbers, two of the finest races in Africa, and, although they were numerically smaller, he thought he might also have mentioned the Arabs, who had spread their civilisation and culture all over North Africa. Of whatever stock the Mohammedan nations might be, the influences which Islam had put upon them could not be denied. In that sense even the story told in the paper was to a certain extent true, but in the opposite sense. All Mussulmans tended to receive the stamp of the teaching and of the civilisation of Islam, the great point about which was that it aimed at social equality as between different races in a large community. If Islam was correctly pictured, it must be allowed that its cardinal doctrines involved the setting aside of mere racial distinctions, in so far as they operated in keeping peoples apart; and if that was the case, as no doubt it was, the time could be looked forward to when Islam and the Moslem people would be able to work side by side with Europeans and Americans to the common advancement of the interests of the whole human race.

SIR ROBERT W. PERKS, BT., in moving a vote of thanks to the author for his most instructive paper, said that this country had, unfortunately, in the past too often formed its opinions on the commercial and political situation of foreign countries from the reports of Consul-Generals who had been far too frequently German in their origin and in their sympathies, and he trusted that care would be taken in the immediate future that information concerning the countries with which we were so closely associated did not come from Consular Agents of foreign extraction, but that opportunities would be afforded of listening to men like the author, who possessed information concerning countries so closely associated with the British Empire. He had listened with great attention to that portion of the paper dealing with the policy of France in assimilating the nationalities over whom she had control in Northern Africa. In his opinion that policy was unquestionably sound, and a divergence from it was bringing some nationalities at the present time into considerable trouble. For instance, the only portion of the great Republic of Brazil which was at present a source of trouble and of serious military danger to the Government were the southern provinces, largely peopled by Germans, in which the Brazilian Government had allowed all public notices to be circulated in Portuguese and in German, and had permitted those two languages to be taught in the elementary schools. The policy in the British dominions had been quite the reverse. A few years ago, when visiting a school at Winnipeg, the teacher informed him that there were 1,700 children in the school of thirty-five nationalities, but only one language, English, was taught; and that was, he thought, on the whole a wise policy to pursue. The Society was very much indebted to the author for his paper, because he came from that class of the community to which Mr. Harold Cox belonged—the men who thought for, wrote for, and instructed and criticised the people of the country, who thrived under their mild but valuable control. They even made ministers, and they sometimes created and uncreated

cabinets. Their power was despotically, but on the whole generously and wisely, used. The Society recognised the author as not only an accomplished Frenchman, a firm friend of this country, but also as a distinguished journalist, whom they thanked for his brilliant address.

The Hon. Sir John McCall (Agent-General for Tasmania) formally seconded the motion, which was carried unanimously.

Captain Millet, in reply, thanked the various speakers for the very kind remarks they had made, and in particular Sir Harry Johnston for the letter he had written in which such a feeling reference was made to his father's work in North Africa. He desired to assure Mr. Yusuf Ali that he was no enemy of Islam. On the contrary, he had fought a good deal to get the French administration in North Africa to accept a more liberal form of government in regard to the natives than they had hitherto adopted. After being romantic for so long, the French were getting to be a practical people at last; but it must be borne in mind that if an endeavour was made to emancipate on a wholesale scale the natives of Algeria and Northern Morocco, exactly the reverse effect would be obtained to that aimed at. While there were a few educated men who, like Mr. Yusuf Ali, were as advanced in civilisation as Frenchmen, there was an enormous gulf between such men and the mass of the *fellahs* working on the land and even in the towns, which constituted the great mass of the population. It was necessary, therefore, to be careful lest a leap in the dark was made and things went on too fast. That was the whole explanation of the policy which he had tried to define, and which he believed was going to be more and more the policy of the French Government. He also desired to be allowed to thank Lord Blyth for presiding over the meeting and for the very kind remarks he had made.

THE PAPER TRADE OF CHINA.

The following particulars, communicated by the Assistant British Commercial Attaché at Shanghai, are published in the *British Chamber of Commerce Journal* (Shanghai):—

In comparison with the great population of China, the import trade in foreign paper cannot be said to be great, yet the aggregate of the business done is far from being unimportant, and a study of the figures of the returns of recent years will show that the trade is expanding annually.

The value of imports of paper and cardboard into China in 1915 was 6,375,765 Hk. taels,* as compared with 6,724,761 Hk. taels in 1914, and 7,212,982 Hk. taels in 1913, and with a total in 1908 of 3,733,775 Hk. taels. It will be seen that the value of the trade has increased in the last seven years by about 75 per cent. The return for 1915 cannot, however, be considered a fair indication of the market, as for many months the demand for certain classes of paper could only partially be met by foreign manufacturers.

The classes of foreign paper most in demand consist of the following varieties: Machine-glazed cap; cap, one side calendered; printing paper, calendered, uncalendered, and coloured; newsprint, cheap qualities; cover and art paper; glazed and tissue paper; kraft and wrapping paper; and strawboard.

Machine-glazed cap is manufactured particularly for the China market, and exceeds all other varieties in the import returns. It is almost a tissue paper, and to understand the large demand for this unusual class, one needs to be familiar with Chinese forms of books and pamphlets. A great many Chinese books, pamphlets and folders are printed with uncut leaves, the printing being only on one side of the paper, and the intervening pages left blank. Thus each leaf of a book is really two leaves, and machine-glazed cap is employed for the purpose. Machine-glazed cap is imported in sheets 25 in. by 44 in., 500 of which weigh 16½ lb. This paper is furnished in large quantities by Norway and Sweden, and to a lesser extent by Germany and Austria.

Pink, green, yellow and orange printing papers are used for posters, street advertising, etc., and may be glazed on one side, but are mostly unglazed. Cheap newsprint has a large sale, as it is this quality which is used for Chinese newspapers. It is imported in sizes 31 in. by 43 in. (500 sheets weigh 37 lb.), other sizes being 27 in. by 40 in. and 25 in. by 35 in. This paper is also made use of for posters and handbills, express notices, street advertising, Chinese account books, scribbling pads, etc., and further as wrapping paper in silk shops, as lining for tea boxes, and for many other purposes.

Cover and art paper, both glazed and embossed, is much employed for covering fancy boxes and for making Chinese envelopes. Glazed and tissue papers, in white and in many bright colours, are employed in making paper ornaments and artificial flowers, and for many other purposes of a similar nature. Kraft and wrapping paper have a fairly large sale, but no actual figures of imports can be obtained. The demand for this class is much under that for printing paper. Strawboard, purchased by the ton, is imported in large quantities and in all weights, almost entirely from Japan.

The following table shows the value of the imports of paper and cardboard into China

* The average value of the Haikwan tael was 3*s.* 0¼*d.* in 1913, 2*s.* 8¼*d.* in 1914, and 2*s.* 7⅛*d.* in 1915. 100 Haikwan taels = 111.40 Shanghai taels, for which exchange quotations are made.

from the principal countries engaged in the trade in 1913, 1914, and 1915 :—

From	1913.	1914.	1915.
	Haikwan taels.	Haikwan taels.	Haikwan taels.
Japan (including Corea)	1,397,949	1,500,074	2,115,152
United States of America	59,856	159,696	1,005,828
Hong-Kong	1,522,779	1,526,106	980,690
United Kingdom	849,658	842,400	735,546
Sweden	1,335,814	983,543	698,347
Norway	271,135	393,972	521,636
Russia	85,321	104,335	151,841
Netherlands	10,045	8,312	19,751
Denmark	20,311	61,928	14,705
Germany	1,083,201	700,851	10,180
Austria-Hungary	380,813	231,562	—

From these figures it will be seen that Japan furnished about 33 per cent. of the total imports of paper and cardboard in 1915. The portion entered through Hong-Kong is entirely imported from foreign countries, to be ultimately distributed to South China cities.

While the figures presented do not show that the trade in paper, when compared with that of other countries, is as yet large, still they show that it is in a growing and healthy condition, and there can be no doubt but that a permanent and increasing demand for foreign paper of many varieties will continue to exist. It is improbable that any great extension of paper manufacture along modern lines will be followed in China for some time to come, and foreign paper will be required to supply the increasing demand. The many political changes within the country in recent years have been the means of vastly increasing the number and circulation of native newspapers; publishing houses for the production of school and other books have come into existence, and their number is being constantly added to; and advertising, both by foreign dealers as well as by Chinese themselves, is much in vogue—all of which contributes towards the increased demand for foreign paper and paper requisites in the China market.

INDIGENOUS INDIAN DYES.

The recent crisis in the dyeing trade, consequent upon the stoppage of the supply of German dye-stuffs, lends special interest to an article on "The Dyeing Values of Some Indigenous Dye-Stuffs," by Mr. J. P. Srivaslava, M.Sc., Technological Chemist, Cawnpore, which appeared in the Special Indian Science Congress number of the *Agricultural Journal of India*. The article summarises the results of an investigation into the dyeing values of certain natural colouring materials still used by native dyers, which was undertaken on the instruction of the Director of Industries, United Provinces. The colouring matters, which were tried on wool and cotton by some of the more important methods of modern dyeing, were :—

(1) Harsinghar (*Nyctanthes arbortristis*). The flowers of this tree contain a beautiful yellow colouring matter, which is soluble in water and in alcohol. It gives brilliant yellow shades with all mordants on wool, while on wool mordanted with bichrome and oxalic acid before dyeing a beautiful brown is obtained.

(2) Tun (*Cedrela toona*). This tree occurs frequently in the sub-Himalayan forests.. The flowers, which contain a yellow colouring matter, are dried and sold. A good shade is obtained on wool, but the dyeings are not very fast to milling with soap and soda.

(3) Tesu or Dhak (*Butea frondosa*). The flowers of this tree, which grows abundantly all over the United Provinces, contain a yellow colouring matter. The dyes on wool vary from brown to dull crimson, according to the mordant used, and are fairly fast to milling.

(4) Haldi or Turmeric (*Curcuma longa*). This is a dried rhizome or tuber, and a well-known constituent of curry powder. It contains a brilliant yellow colouring matter, which, however, possesses the serious drawback of being changed into red by soap or alkalies. The colouring matter, called *curcumin*, is sparingly soluble in cold water, more freely in hot water, and completely in alcohol. On wool the best

shade is obtained on chrome mordant, and the fastness is fair.

(5) Arusa (*Adhatoda vasica*). This is an evergreen plant, which grows in the United Provinces. The leaves yield a yellow colouring matter, *arusa*, which is soluble in water and also in alcohol.

(6) Naspal or Pomegranate Rind (*Punica granatum*). The rind contains a tanning substance and also a yellow colouring matter, which dyes very good shades varying from yellow to full brown on wool. All these possess very good fastness to milling.

(7) Jangli Nil or Wild Indigo (*Tephrosia purpurea*). This is a small woody annual, occurring abundantly in the United Provinces. Its name is due to its similarity to the indigo plant, but it does not contain any substance yielding indigo. The colouring principle is allied to quercetin. Owing to the difficulty of separating the yellow principle from the chlorophyl, efforts to secure a pure yellow have only been partly successful, but the colouring matter is of great value, as it yields dyeings which are comparatively fast to light, washing, and milling.

(8) Safflower, or Kusum (*Carthamus tinctorius*). The dried flowers of this plant contain a colouring matter which before the introduction of coal-tar colours was highly prized all over the world. It produces on cotton beautiful shades of red, varying from a full crimson to the most delicate pink. Safflower contains two distinct colouring matters: (1) a yellow, soluble in water, which is by far the larger constituent, and (2) a red, which only occurs in small quantities, but is the more valuable of the two. It seems that the Egyptians at an early period were acquainted with the safflower yellow dye.

(9) Majith (*Rubia cardifolia*). The root and twigs of this plant contain a dye-stuff identical with madder. It was largely used in India before the advent of synthetic alizarine, but its cultivation has ceased, although it is once again in great demand. It is undoubtedly one of the most valuable indigenous dye-stuffs. With its help, maroon and bordeaux shades of excellent fastness to light can be dyed on all fibres. It is the basis of a great many colours required by calico-printers.

(10) Cutch or Katha (*Acacia catechu*). This tree is found in several parts of India. An extract made by boiling the wood in water is still largely used in dyeing. Catechu is exported to Europe for use both in dyeing and tanning. It may be applied to all fibres, though it is most largely used on cotton. Catechu brown is one of the fastest colours known.

(11) Patang or Sappan Wood (*Cæsalpinia sappan*). This is a variety of the so-called Brazil wood, which was once very largely used for dyeing in Europe. The colouring principle, *brazilein*, exists in a colourless condition in the freshly-cut wood, and is by oxidation converted into the true colouring matter. The wood is similar in its composition to logwood. Patang is a valuable colour-yielding material, and produces brilliant shades of red, crimson and purple.

(12) Lac dye is still manufactured largely in certain parts of India, though it has lost much of its former importance. It yields beautiful scarlet and crimson shades.

(13) Indigo. The uses of this most valuable dye are too well known to be described in this short article.

(14) Kachnar (*Bauhinia racemosa*). The bark of this shrub yields a colouring matter which is employed for dyeing dull reds on cotton, on which it may be used without any mordant. It is also said to be used in Burma for obtaining a dull black on cotton. In this case it is dyed direct in an infusion of the bark, and is then worked in mud whereby the dull red is changed to black. The bark can be had in any quantity, and may be of service to tent manufacturers who require a dull red colour for the inside of tents.

(15) Peepul (*Ficus religiosa*). The roots of this contain a red dye, which gives a good pink on cotton mordanted with alumina. The shade so obtained is fairly fast.

(16) Red Sanderswood (*Pterocarpus santalinus*). The wood of this tree yields a valuable red dye, which was largely employed before the advent of synthetic dyes. It can be used on wool without any mordant, while very good shades of satisfactory fastness are obtained on cotton with tin and alumina mordants.

(17) Roli or Kamela Powder (*Mallotus philippinensis*). This dye is obtained from a small tree found along the foot of the Himalayas and in Southern India. It used to be largely employed for dyeing silk, on which, with alumina mordant, it gives a beautiful yellow.

(18) Akhrot (*Juglans regia*). The bark yields a valuable brown dye, which is of special importance for wool at the present moment, because on this fibre it gives a fast shade that may easily be modified to a khaki.

(19) Kathal (*Artocarpus integrifolia*). The wood yields a yellow colouring matter which may be dyed on cotton on alumina mordant. The shades are good and fast.

(20) Barberry (*Raswal*). The bark, roots, and stem of this plant are rich in a very good yellow dye, which is chiefly used for silk. The dye principle is berberine, an alkaloid containing nitrogen.

(21) *Rhus cotinus*. The wood of this plant yields a dye similar to young fustic. On cotton mordanted with alumina an orange yellow was obtained; with tin, an orange red. The dyeings, however, are not fast to alkalies and soap.

It may be interesting to compare the foregoing list with the list of dyes commonly used by English dyers in the eighteenth century.

These were nearly all vegetable. "The principal were logwood, fustic (from the *Maclura tinctoria*); Brazil-wood (*Cæsalpinia brasiliensis*); madder, woad, 'Indico,' 'made of a weed of the same nature with woad'; woodwax (*Genista tinctoria*, or greenweed); wild (*Reseda lupeola*, or dyer's mignonette) and arnotto. Cochineal was another important dye. The mineral ingredients include arsenic, verdigris, and copperas (ferrous sulphate), which was used with oak galls for making a black dye . . . Then there were what were really mordants, though the principle of their action was unknown. Chief of them was alum . . . but 'aquafortis impregnated with pewter,' which would seem to provide a solution of impure lead and tin nitrates, is also mentioned, and so are saltpetre and argol (bitartrate of potash)."*

PINE-APPLE GROWING IN SOUTH AFRICA.

The following particulars are taken from a paper, dealing with pine-growing in the Bathurst district, read by Mr. E. H. Crouch at the last meeting of the East London Farmers' and Fruit Growers' Association :—

Twenty miles south of Grahamstown stretches Belmont Valley—surely one of the most charming valleys in the Eastern Province. At its southern end it opens out on to Manley and Martindale Flats, looking somewhat treeless and bare after the luxuriant growth the train has just passed through, and still further southward, merging into these flats, lies the rich district of Clumber, all marked out like a great irregular chess-board in squares of green, purple, and brown. These are the plantations of pines in various stages of development. At first the traveller mistakes them for ploughed lands, but on closer inspection long vistas of pine plants develop. There they lie, in perfect line, once in the individual stage, six feet apart, now developed until there is scarcely walking space between, so thickly have the young pines clustered around the parent stock. It is a unique sight, not to be witnessed anywhere else in the Cape Colony—thousands, nay, millions of them.

To plant out 50,000 pines is but a small beginning. Pines must be handled in quantities. Messrs. Crouch Brothers, near Martindale, have just prepared ground for 100,000 plants. On the adjoining farm of Mr. Staples there are 250,000 plants, and this is but one of the three such plantations. He now controls altogether between 2,000,000 and 3,000,000 pines. Mr. Long, a young energetic farmer, whose ambition extends beyond the limits of his own farm, has made a beginning with 300,000, and intends doubling that amount this season. To right and left of him again are dozens of farms, each counting their stock by the hundred thousand. A near neighbour of his, Mr. E. A. Purdon, has probably 500,000 choice pines, and he, too, is planning still greater things. And so as you ride on the map unfolds. Breaks, of course, there are on this great chess-board, spaces set aside for an ostrich camp, or an apple or orange grove, but looked at broadly the whole sweep of this rich Clumber land is devoted to the pine industry. The distant Bathurst hills are roughly its southern limit, and here the pine gives place to apple plantations of 2,000 and 3,000 trees. It is a tale of energy, enterprise, and great faith.

To the Purdon family belongs the honour of introducing to South Africa this queen of fruits. Mr. Purdon, sen. (father of the present E. A. Purdon, of Pinedos), brought out to Natal, some sixty years ago, half-a-dozen pine plants. These bore well, and he got with ease 7*s*. 6*d*. for each pine on the Grahamstown market. Mr. Purdon was a shrewd man; he realised he had "struck oil," and, "lest he should flood the market," as he naively termed it, restricted his plants to about one hundred. To-day his son owns about half-a-million plants, sends his fruit away by the truck-load, and is quite satisfied if he realises sixpence per dozen. So jealously did one of these early growers guard his plants and endeavour to restrict the industry, that it is stated a near neighbour only procured his first fruit through the carelessness of a native going to market and throwing the top of a pine which he had been eating out on the road. This the farmer picked up, cherished, and to-day his farm forms part of Langholm Estate with 2½ million plants. So suitable is this climate for pine-growing that it is almost a matter of indifference what soil is broken up for planting. The red rich soil common here, stoney slopes, or the loose sandy soil of Martindale and Trapps Valley are equally adaptable. After all, the pine plant is but a species of the cactus tribe, and, as we know, the cacti thrive best on dry, rocky—to agriculturists, almost worthless—soil. The pine needs little moisture, and when once the plant has struck root all that is necessary is the cleaning hoe. It draws moisture freely from the air, and the result is that the base of a cluster of pine plants is always moist—so moist, indeed, is the soil, that one farmer had dug circular holes amidst his thickest cluster of pines with the object of planting young orange trees there. The pine was to wet-nurse the citrus tree. By way of illustrating the moisture-conducting power of the pines, a farmer showed me, in the ravine below his pine plantation, which had always been dry, two good fountain holes which had only developed since the slope had been planted with pines.

More than one farmer in the Bathurst district has made his fortune out of pines. Of course, the fancy prices of a few years ago are not now

* "Industrial England in the Middle of the Eighteenth Century." By Sir Henry Trueman Wood.

obtained for the fruit. But quantity tells, and the man who can turn out a hundred dozen a day is on the road to fortune. Even at the present rate, 6*d*. to 1*s*. per dozen, they pay handsomely. Hitherto the single farmer has had it all his own way; now the trust has slipped in, and intends "making things hum." It is urged by those who know, that the fourth year after planting an acre of pines will make a minimum yield of £50 (Mr. Heugh, the horticulturist, claims that £60 and upwards per acre per annum can easily be netted). The rest is purely a matter of arithmetic. Ten acres of pines at the end of four years will represent estate value £1,000. "Flood the market" you exclaim, and rightly so; but in the very quantity lies salvation. Twenty million is the aim of the Langholm Estate. This means that the shipping companies will grant shipping facilities where now they restrict them. It means strong company compulsion against spasmodic individual effort, and securing such terms as now are quite impossible. London alone will absorb this prospective output, and such large markets as Paris, etc., will still be left unsatisfied.

SAPPHIRE-MINING IN ANAKIE, QUEENSLAND.

The *Bulletin of the Imperial Institute* (Vol. XIV. No. 2) contains an interesting account of the mining conducted in the Anakie sapphire field of Central Queensland. Sapphires were discovered in this area about forty years ago. At first, owing probably to the fact that the stones presented novelties and colour, they were not in much demand; but after various ups and downs the industry gradually improved its position until it reached its record year in 1913, when the estimated value of the output was £43,292. On the outbreak of war, however, the industry collapsed, mainly because the buying, cutting, and retailing of the stones had fallen into German hands; but arrangements have now been made to market the stones in London, and operate quite independently of enemy countries, so that the prospects of the trade are once more hopeful.

The crystalline form of the Anakie sapphire is fairly typical. The hexagonal pyramid is common, but the prism is comparatively rare. The usual rhombohedral form also occurs, and crystals are frequently terminated by a basal plane. Stones of the star-sapphire type, showing the phenomenon of "asterism," also occur.

The specific gravity of many specimens which have been examined has varied from 4 to 4·05. The colour is variable and includes sapphire, "oriental amethyst," "oriental ruby," "oriental peridote" (green), "oriental chrysoberyl" (yellowish green), "oriental topaz," "oriental cat's eye" (smoky), and "oriental moonstone." Opaque varieties are generally black, but are sometimes brownish-black, dark blue, light blue, and greyish white.

The youngest geological formations of the Anakie district are alluvial deposits and flows of basalt. Peaks of the latter occur in many places, but no extensive sheets of it are known at present. It is suspected, however, that basalts formerly covered a wide area, and that they have been largely removed by denudation. Some of the basaltic peaks reach a considerable altitude, heights of 2,000 ft. and more above sea-level being recorded.

The study of the basalt has thrown some light on the problem of the origin of the sapphire. At Mount Hoy, spinel of the pleonaste variety was found to occur abundantly in the basalt, and the crystals had the appearance of being corroded. A specimen of pale blue sapphire was found on the summit of Mount Hoy, at a height of 500 ft. above the highest of the sapphire-bearing alluvial deposits, and it is considered that the sapphire, like the pleonaste associated with it, was weathered out of the basalt.

At Mount Leura, one of the loftiest of the basalt peaks, a piece of bronze-black corundum was found embedded in the basalt. Other minerals enclosed in the basalt at Mount Leura are pleonaste, ilmenite, hornblende, olivine, plagioclase, and quartz, all of which show corrosion effects. From the summit of Black Peak, the highest of the basalt peaks, pleonaste, ilmenite, hornblende, and corundum were obtained.

An interesting occurrence of basalt is that at Policeman Knob, where an old alluvial deposit lying on mica schist is covered by a sheet of basalt. Here zircons are numerous in the alluvial deposits underlying the basalt, but sapphire is not associated with them. This occurrence of zircon and absence of sapphire in the alluvium underlying the basalt, taken in conjunction with the proved occurrence of corundum in and on the basalt, leads to the conclusion that the sapphires have probably been derived from the basalt. Confirmatory evidence of this is provided by the fact that basalt is associated with sapphire in the sapphire-bearing gravels.

The thickness of the sapphire-bearing alluvium varies considerably in different parts of the field. In some places it is only a few inches thick, in others several feet. At its base there is frequently a layer of reddish clay resting on decomposed schists and slates. In some instances, however, sapphire-bearing gravel underlies this layer of clay. The sapphire is not distributed uniformly through the gravel.

Minerals other than sapphire found in the sapphire-bearing gravels include spinel, garnet, zircon, quartz (rock crystal, amethyst, and cairngorm varieties), chalcedony, rutile, magnetite, ilmenite, tourmaline, hornblende, topaz, and diamond. The last, however, appear to be very scarce.

The mining of the Anakie sapphire deposits has been carried on by holders of small claims, and their methods have been rather simple and perhaps inefficient. The methods of digging adopted are described as: (1) "Surfacing," or simply removing and treating the soil; (2) "deep surfacing," which necessitates the removal of several feet of overburden that may or may not carry sapphire; and (3) sinking shafts through the overburden into the sapphire-bearing gravel.

Where the gravel is coarse and the sapphires are fairly large, hand-raking is adopted and the gems are picked out. Otherwise sieves are used to screen the material. One type is a small circular sieve swung from a tripod. Another type is a double screen, the upper sieve of which has a 1-in. or 1¼-in. mesh, whilst the lower sieve has an ⅛-in. mesh. The material that passes the upper sieve and is caught on the lower one is reserved for further treatment in a rotary machine, which may be driven by hand, horse, or engine. Oil engines have been introduced and used successfully for this purpose.

The yield of the gravel varies. At one working the average yield per load is given as ½ oz. of "parcel blues," ¼ oz. "small blues," and 1½ oz. "machine stone." "Parcel blues" are defined as those of medium size; "small blues" are mostly less than 1 carat in weight; "machine stones" are defective in colour and are up to ½ oz. in weight.

At some workings "fancy" stones are sought chiefly, and the yield of stones of this character is uncertain. Large blue stones and coarse corundum crystals are obtained in some places. Gravel yielding ½ oz. of "parcel blues" per load can generally be worked without loss; but if less than a foot of gravel has to be mined, a return of 1 oz. per load may be necessary for profitable working.

In April 1913, the prices realised for stones were 5*s.* to £5 per dwt. for fancy stones; £2 10*s.* to £6 per oz. for large blue stones; 35*s.* per oz. for parcel blues; 7*s.* 6*d.* per oz. for small blues; and 3*s.* to 3*s.* 6*d.* for machine stones.

Much of the corundum and sapphire found at Anakie has proved to be valuable for mechanical purposes, and when free from fracture, though it may be useless for ordinary gem purposes, can be made into small bearings and pivots for parts of machines running at high speeds.

SURMA VALLEY PINE-APPLES.

The *Englishman* states that there is an excellent prospect of establishing a central pine-apple canning factory in the Surma Valley district. A ryot with a standby in the shape of a pine-apple bari, planted with the best varieties which are now procurable, need never fear the wolf of starvation. Of course, he would have to plant upon land which had no chance of suffering from floods, and there are thousands of acres of such at the present time under scrub jungle on either side of the Assam-Bengal Railway. There would appear to have been an idea that the superior varieties of pine-apples required lifting and replanting every time they fruited. It has now been ascertained from pine-growing countries that if the plantation receives care it is, practically, a permanency. Prevention of overcrowding and top-dress manuring are essential to success. Various opinions exist in countries where the pine-apple is grown extensively as to the best kinds of manures to use. Different kinds of soils, no doubt, are responsible for divergencies of opinion in this respect. Most growers agree that the pine-apple is a gross feeder, and that rich feeding, if rationally given, may double the weight of fruit per acre, and at the same time have no deleterious effect on the flavour and quality of the fruit. For canning purposes the larger the fruit the better, if the flavour and quality are up to the best standard. A small fruit is not so profitable either for the grower or preserver, as, weight for weight, the smaller fruit has much less preserving material in the shape of pulp. According to a Cuban grower, 9,000 fruits per acre are a fair average, but more than double that number are produced in Florida, where 20,000 to 30,000 plants are crammed into the acre, and artificial manuring is largely practised. Cow manure and oilcake as sources of nitrogen have been successfully used in the Surma Valley. Sulphate of potash, when the plants are swelling, improves size and quality. As a complete manure for pines, it has been found that animal meal is as valuable as it has proved in tea cultivation.

ENGINEERING NOTES.

Aviation, Present and Future.—Colonel Lord Montagu, C.S.I., Inspector of Motor Vehicles, who gave a lecture at Delhi recently, took the above for his subject. Turning from the present-day accomplishment to the possibilities of the future, he sketched plans for an aerial mail and passenger service between India and England, which he stated he was certain would be an accomplished fact within the next ten years. The sea route from Bombay to London was about 6,000 miles, or *viâ* Marseilles about 5,000 miles, but by aeroplane over Russia and Germany the journey would be only 3,600 miles, and the mails by this route, travelling day and night, could reach London in less than thirty-six hours. As far as the passenger service was concerned, allowing for a rest of fourteen hours out of the twenty-four and travelling 120 miles per hour, 1,200 miles would be covered in a day. Thus from Delhi to London would occupy sixty-four hours. The first night, passengers would sleep at Gaurieff, at the head of the Caspian Sea, the second at

Tarnol, near Lemberg in Galicia, and on the third day, in the evening, they would dine at the Ritz in London. Another route, which he called an "All-Red Route," would be 5,220 miles, namely, from Karachi *viâ* Basra, Alexandria, Malta and Gibraltar, the Mediterranean portion of the journey being accomplished by seaplane, and on the fifth day passengers would arrive in England. Landing-places would be illuminated and distinguished by lights of various colours, and the route indicated by miniature lighthouses. There would be a reduction in fares by the air route, as he estimated the charge would require to be about £40 for the single and £70 for the double journey. At a lecture given by Mr. G. Holt Thomas, on May 30th, before the Aeronautical Society of Great Britain, additional particulars to the above were given. He said that from London, Ceylon would be reached by mail in 2¾ days, Tokio 4½ days, Sydney 5 days, Capetown 3½ days, and Vancouver 3 days. As to passengers, Constantinople could be reached in twenty hours at a cost per ticket of £25, or mails at 2½*d.* per ounce.

Electricity and the Growth of Crops.—Many years ago the present writer attended a lecture given on the above subject, by the late Sir William Siemens, at the Institution of Civil Engineers. He showed the progress of a pot plant under the influence of electricity, which caused great interest at the time. The matter seems to have been, to some extent, forgotten meanwhile until attention to it was called by the meeting of the British Association in 1898, when papers on the subject were read by Mr. E. H. Cook and Mr. S. Lemström. On January 22nd, 1914, a paper on the electrification of the atmosphere, natural and artificial, including the topic of plant growth by the influence of electricity, was read by Sir Oliver Lodge, F.R.S., being the fifth Kelvin Lecture. He spoke of the efforts of Holtz, Voss, and Wimshurst, besides those named at the British Association meeting in 1898. Some trials were made by the Electric Discharge Co., of Gloucester, and near Bevington in Worcestershire, and Sir Oliver Lodge seemed to have thought that where there is a lack of sunshine electricity ought to have a good effect. In the present dearth of foodstuffs, a recent issue of the *Electrical Review* is of special interest, describing a farm at Dumfries where electricity has played, for the last year or two, an important part. The results apparent in 1916 were shown by Professor J. B. Blackman and Mr. Jorgensen in the *Journal of the Board of Agriculture*. Briefly, the conditions were as follows. The soil was sandy loam and the crop oats. One acre was chosen, two half-acre lots serving as controls. The wires were kept low, 7 ft. from the ground, sagging about 1 ft. A series of twenty-one wires were erected parallel to the short sides of rectangles 88 yards by 55 yards, wires being about 4½ yards apart. No. 24 gauge silicium bronze wires were used. The primary current was 3 amperes at 50 volts. The crop was sown March 27th, 1916, and appeared above ground April 13th, 1916, and the discharge was started the next day. By May 16th the crop was of a markedly deeper green.

Electrified Area.	One Acre.	Control 1.	Control 2.
June 18th .	19 in.	14 in.	12 in.
June 25th .	24 in.	19 in.	18 in.
July 3rd . .	32 in.	21 in.	20 in.

After the last date it was not possible to take measurements without damaging the crops. The electrified crop yielded 49 per cent. more grain, and 88 per cent. more straw, than the unelectrified area. The energy used was 130 kilowatt hours, and if reckoned at one penny per unit, amounted to 11*s.* The nature of the particular season, climate, soil, and the crops may, without doubt, largely modify the above, but the general result, namely, the effect produced by the action of electricity on the soil, seems to be noteworthy.

Irish Water Power.—In a recent speech, says the *Electrical Review* in a leading article, which excited a great deal of interest in the *Times* and the *Daily Mail*, Lord Northcliffe declared that the Irish problem, in his opinion, was an economic one, and suggested that the solution would be found in the development of the water-power available in Ireland. He had "sought eagerly for any recent expert report on the water power of Ireland," but without success. Had he consulted the *Electrical Review* he would have found the information he desired, for the subject has been dealt with on various occasions. The *Electrical Review* then proceeds to show that the minimum flow of the Irish rivers is only about one-sixth of the flow of the ordinary maximum, and for industrial purposes, unless the hydraulic plant is supplemented, at great additional cost, with steam or gas-driven plant, it is the minimum flow that fixes the capacity of the undertaking. For other reasons which the *Review* details at length, it seems probable that Lord Northcliffe's optimistic hopes are not very likely to be realised.

A New Electrical Steel Furnace.—*Metallurgical and Chemical Engineering* says that a new type of steel furnace, known as the Greaves-Etchells furnace, is being built by Messrs. T. H. Watson & Co., of Sheffield. It is suitable for making all grades of alloy steels and high-speed tool-steels in small ingots. The furnace is a three-phase furnace, in which two of the carbons are introduced at the top, and the whole of the hearth is connected to the third phase, acting as the third electrode. With a small furnace designed to melt 6 cwt. in three hours, it has been found possible to obtain five heats of 18 per cent. high-speed steel in ten hours. The

longest time occupied from charging to finished ingots was one hour forty minutes, and the shortest time one hour fifteen minutes. This small furnace has already made over 560 consecutive heats of high-speed, and the lining has once been renewed. The standard size in which this type of furnace is being built is for a capacity of 10–12½ cwt., but some furnaces are also being built for larger sizes up to 6 tons.

CORRESPONDENCE.

AMERICAN DRINKING STRAWS.

On page 433, column 2, of the *Journal* of April 27th, 1917, it is stated by Sir Francis Fox, in his paper on "Bread and Flour," that Great Britain furnishes the straw through which Americans take their "soft drinks." It may be of interest to you to know that but little straw is now used for this purpose. An imitation straw of paraffined paper is almost universal.

On page 433, column 1, of the same number of the *Journal*, 30,000 kilos is nearer thirty tons than one ton, as stated in the text.

Palo Alto, California. W. H. SHOCKLEY.
May 20th, 1917.

NOTES ON BOOKS.

TRADE FALLACIES. By Arthur Kitson. London: P. S. King & Son. 5*s*. net.

This volume consists of a number of articles which have appeared in *Land and Water* during the last two years, and it constitutes a criticism of existing methods in our industrial and commercial systems, and suggestions for a reform towards national prosperity. As one who has been engaged as a manufacturer and an employer of labour for over thirty years, both in this country and in America, the author's opinions are entitled to respect, and, whether one agrees with him or not, his views certainly are stimulating and deserving of careful study.

Although the various chapters deal with cognate subjects, they are naturally—seeing the form in which they were first published—more or less detached and self-contained. The best way of conveying some idea of the author's methods seems, therefore, to be to take up one or two of the points which he discusses.

In the chapter entitled "Inadequacy of Our Banks," Mr. Kitson strongly criticises the changes which have taken place in recent years in our banking methods. Before the establishment of the London companies' country branches, the provincial banker was usually a man of wealth, power, local knowledge and sympathy. He was intimately acquainted with the needs of his neighbourhood, and he frequently became a shareholder in his town's local enterprises. Thus, thirty or forty years ago, it was comparatively easy for country tradesmen and farmers to get financial help from their private bankers, and it was generally no hard matter to secure financial support for local undertakings. Now, however, instead of the private banker we have "a manager, who is usually a stranger, and who knows little or nothing of the townspeople themselves, who is usually without any social or political standing, and is powerless to grant any considerable banking facilities without the consent of his London board of directors. His instructions are to secure all the deposit accounts possible, and send as much currency as he can to London. If it were possible for a country manager to acquire country deposits without having to grant loans, the London banks would regard this as an ideal condition." In a word, Mr. Kitson's complaint is that the London banks are constantly denuding the country districts of money in order to grant loans to foreigners for the purpose of building up industries abroad which will successfully compete with our own. Unfortunately much of this money in former days found its way to Germany, and, as Mr. Kitson observes, although the policy has probably helped to increase the banks' dividends, it has blasted scores of British industries. How far the new Trade Bank will go towards remedying this state of affairs remains to be seen.

The only other point to which space permits a reference is in the chapter "Psychology of the Workshop." Mr. Kitson is warmly in favour of any steps in the direction of humanising the workman and regarding him not as a mere machine. Happily there are abundant signs that his view is becoming more and more generally accepted among employers—several speakers at recent meetings of the Royal Society of Arts have given strong evidence of this. The Government itself has made a striking advance by the institution of its Welfare Department, which, as Mr. Kitson says, promises enormous benefits to our industrial classes. He makes a number of other suggestions with a view to increasing the interest of the workers in their work and in life generally. Some of these are excellent, as, for instance, calling the workpeople together two or three times a week during working hours, as is done in the Whitehead aircraft works at Richmond, and explaining to them the nature and value of the work: but there may be two opinions as to the desirability of introducing gramophones with a view to increasing the amenities of factory life.

INDUSTRIES IN BRITISH EAST AFRICA. London: Offices of *South Africa*, 191, Bishopsgate, E.C. 6*d*.

This little handbook is made up of a series of articles reprinted from *South Africa*. They deal with a great variety of subjects, including

cattle, horses, ostriches, pigs, sheep, coco-nuts, copra, coffee, fruit, rubber, wheat, cotton, paper pulp, sisal, timber, wattle and bees. Another article is devoted to the resources of Zanzibar, and the last to cotton-growing in "German" East Africa. Owing to their brevity—the whole handbook only contains twenty-eight small pages —the articles cannot give much detailed information; but they are all excellently written, and taken together they convey the impression that the resources of British East Africa are extremely rich and varied, and that under a wise government the development of the country ought to be great and rapid.

GENERAL NOTES.

DUTCH BROWN BEANS.—These beans are grown in Holland in enormous quantities by all classes of the people, who use the seeds for winter food. Some samples were sent to the Royal Horticultural Society in 1915, and they were grown in private gardens, and a large number also at Wisley in 1916. They were sown the end of April or the first or second week in May, exactly if they were ordinary French beans. As soon as they turned brown, about the end of September, they were pulled up and tied together in small bundles by their roots and hung up in a dry open shed. When quite dry they were shelled and yielded a very large crop of seed, which, on being soaked twelve hours and boiled one and a half hours, were found to be excellent, and decidedly an advance on the ordinary white haricots. A ton of the beans has recently been imported from Holland and distributed among Fellows of the Royal Horticultural Society, who are urged to grow some and give away most of the seed, only saving enough to renew their own supply, in which case a very great addition may be made next year to the general stock of winter food in the country. Those to whom they are given should be warned to grow them only for the seed and not for the green pods.

THE CHEMISTRY OF RHUBARB.—Certain recent cases of poisoning from the eating of rhubarb leaves have drawn attention to the chemistry of the plant. This question, says the *Chemist and Druggist*, has not been exhaustively studied, but the plant has long been known to contain oxalic acid in addition to the calcium oxalate which occurs in the root. *Rheum Rhaponticum* is said to be more acid than *R. palmatum*, but Lindley, writing in 1846 of rhubarb generally, said: "Oxalic acid is copiously formed in both docks and rhubarb." Is there any reason to suppose that there is more of it in the leaves than in the stalks? Parkinson, who seems to have been the first to experiment with rhubarb as an article of food, tried the leaves first, and was led by their "fine acid taste" to suggest that "a syrup made with the juice and sugar cannot but be very effectual in dejected appetites." Rhubarb, however, did not become popular as a vegetable until the early years of last century. It is said that a Mr. Miatt introduced it to the London market about 1820, selling only three of the five bundles which made up his first consignment. Phillips speaks of it in 1822 as in great favour for spring tarts, and highly recommended by medical men for its cooling and wholesome properties. Evidently, however, it does not agree with everyone, and the leaves must be used with caution, if at all.

THE HOUSE FLY.—"The House Fly and its Kindred" is the title of one of the latest "leaflets" (No. 44)* of the School Nature Study Union. This well-illustrated pamphlet will be of interest to all those who were attracted by Dr. Halford Ross's lecture, printed in the *Journal* of March 20th, 1914, and the correspondence which ensued; but its chief interest will be for those sanitary reformers who have not felt satisfied with some more recent efforts to stimulate and further instruct us all in combating the summer "fly-peril." Whilst the concluding part of this treatise indicates how very restricted are the prospects of relief by the remedial measures generally recommended, it bases great hopes of something like a practical extinction of the real house-fly (not of the different wild "outdoor" species) on the much overlooked fact that the creature is a "developed parasite," differing from all others despite of superficial resemblances. It is held that its extermination would be effected by compulsory prohibition of municipal dumping-grounds for the contents of domestic "dust-bins" and by the prompt incineration of all such organic refuse and garbage in municipal refuse destructors. Many prevalent ideas are shown to be erroneous, and some advice based thereon to be injudicious or futile. A warning is given against rashly using some sterilisers, disinfectants, and the like. When applied to matter usable as manure some recommended chemicals may poison horticultural ground or diminish its fertility.

PAPER-PULP INDUSTRY OF JAPAN. — The Japanese demand for paper pulp in 1915, says H.M. Commercial Attaché at Yokohama, was 145,000 tons, of which 60,000 tons was ground pulp and 85,000 tons chemical pulp. Ground pulp was chiefly supplied by home producers, only a small portion being imported. Of chemical pulp, about 60,000 tons came from abroad, the home production being limited to 25,000 tons of lower grade material and 7,500 tons of superior grade. The total cessation of

* Single copies, 2½*d.*; per dozen, 1*s.* (post-free), of Mr. H. E. Turner, 1, Grosvenor Park, Camberwell, S.E.

imports of pulp into Japan since the war began and the enormous rise in prices have stimulated the Japanese pulp industry. Many producers are now exploiting the timber resources of the Saghalien forests, and several chemical paper factories have been established recently in Saghalien. With a view to encouraging the pulp industry in Japan, the Japanese Economic Investigation Committee suggests that timber for pulp-making should be supplied at the lowest possible price, and that all possible facilities for the transport of material, timber, and pulp should be given to producers.

East African Hides.—One of the most important factors in the trade of British East Africa during the past ten years has been the export of hides. The latest available statistics, says *South Africa*, are for the year ended March 31st, 1915, when 48,054 cwt. left for Europe. Since then, owing to military operations, cattle have been largely used for transport purposes as well as food, with a resulting scarcity of stocks. Large quantities of hides have accumulated at trading centres, and attention has been turned thereto with a view to the establishment of tanneries. In consequence of the careless manner in which hides have hitherto been prepared for the market, they have not been so well received as circumstances should warrant. The natives are inclined to leave flesh on the hide in order to increase the weight. They are also given to unnecessary branding of cattle, regardless of the effect on the hide. Native hides are divided into four classes: "Calfskins" (weighing up to 6 lb. each), packed fifty or sixty to the bale; "lights" (weighing from 6 lb. to 12 lb.), packed thirty to forty to the bale; "mediums" (weighing from 12 lb. to 18 lb.), packed twenty-five to the bale; and "heavies" (weighing 18 lb. and over), averaging eighteen to the bale. All bales weigh 300 lb. to 380 lb. each, with an average of about 350 lb., and the measurement ranges from 30 cubic ft. to 40 cubic ft. per bale. The hides were formerly shipped in loose bundles; but, as space is the main charge with the shipping companies, pressing machines have been introduced, which has increased the weight per cubic foot. The industry has attracted more than usual attention of late, and some activity is expected in the near future.

The Freezing Point of Mercury.—The United States Bureau of Standards has completed a very careful determination of the freezing point of mercury, using platinum resistance thermometers to measure the temperature. The result of this work gives $-38 \cdot 87°$ C. ($-37 \cdot 97°$ F.) for this point. It is interesting to note that as far back as 1862 the British Government, recognising the importance of an accurate knowledge of this point, appropriated £150 to have it determined. The value then obtained, $-38 \cdot 85°$ C. ($-37 \cdot 93°$ F.), is in close agreement with that obtained at the Bureau of Standards. However, other determinations made previous to and after this early work cast some doubt on its accuracy. A knowledge of the freezing point of mercury is of great importance to thermometer makers, as it marks the lower limit to which a mercurial thermometer may be used, and furnishes a method for calibrating or printing the scale below 0° C. (32° F.).

MEETINGS FOR THE ENSUING WEEK.

Monday, June 18... Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Sir Frank W. Dyson (Astronomer-Royal), "The Distances of the Stars."

Geographical Society, Burlington-gardens, W., 8.30 p.m. Major E. A. Steel, "The Zambezi-Congo Watershed."

Tuesday, June 19...Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Professor J. S. Nicholson, "Statistical Aspects of Inflation of the Currency."

East India Association, Caxton Hall, Westminster, S.W., 4.15 p.m. Mr. C. C. James, "Forty Years' Sanitary Progress in Bombay."

Wednesday, June 20...British Academy, at the Royal Society, Burlington House, W., 5 p.m. Dr. W. H. Hadow, "Beethoven."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Mr. C. E. P. Brooks, "The Reduction of Temperature Observations to mean of 24 hours, and the elucidation of the Diurnal Variation, in the Continent of Africa." 2. Mr. F. J. W. Whipple, "Autographic Records of the Air-wave from the East London Explosion, January 19th, 1917." 3. Mr. R. C. Mossman, "Some Aspects of the Cold Period, December, 1916, to April, 1917."

Microscopical Society, 20, Hanover-square, W., 8 p.m. Messrs. E. Heron-Allen and Arthur Earland, "On *Nouria rugosa*, a New Species of Foraminifera from the Faroe Channel."

Thursday, June 21...London Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. M. Paul Lambotte, "Impressions of London."

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8 p.m.

Aëronautical Society, Central Hall, Westminster, S.W., 8 p.m. Colonel Lord Montagu of Beaulieu, "The World's Air Routes and their Regulation."

Friday, June 22...Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Correction.—In the report of the discussion on Mr. R. S. Pearson's paper on "The Recent Industrial and Economic Development of Indian Forest Products" (*Journal* of June 1st, 1917, page 504, column 2), Mr. William Powell was said to have "referred to an article by himself published some four years ago in the Indian Forest Records (Vol. III. Part II.) on the antiseptic treatment of timber in India." Mr. Powell writes to say that the article was written by Mr. R. S. Pearson, not by himself.

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Journal of the Royal Society of Arts.

No. 3,370. VOL. LXV.

FRIDAY, JUNE 22, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

FINANCIAL STATEMENT FOR 1916-17.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws:—

TREASURERS' STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING MAY 31st, 1917.

Dr.

	£	s.	d.	£	s.	d.
To Cash in hands of Messrs. Coutts & Co., May 31st, 1916				1,554	2	6
,, Subscriptions	4,149	10	0			
,, Life compositions	502	11	0			
				4,652	1	0
,, Dividends and Interest				507	5	5
,, Ground Rents				558	0	4
,, Examination Fees				3,482	14	6
,, Advertisements				46	13	9
,, Sales, etc.:—						
Cantor Lectures	7	8	3			
Examination Programmes and Advertisements	117	4	7			
Fees for use of meeting-rooms	92	18	6			
Journal	122	12	6			
Leather Committee Reports	0	5	0			
				340	8	10
,, Donation to Examination Prize Fund:— Clothworkers' Company				40	0	0
,, Loan from Messrs. Coutts & Co., for the purchase of War Loan				1,900	0	0
				£13,081	6	4

Cr.

	£	s.	d.	£	s.	d.
By House:—						
Rent, Rates, and Taxes	847	15	0			
Insurance, Gas, Coal, House expenses, and charges incidental to meetings	315	6	11			
Repairs and Alterations	30	6	5			
				1,193	8	4
,, Office:—						
Salaries and wages	2,698	13	11			
Stationery, Office Printing and Lithography	366	16	1			
Advertising	33	0	0			
Postage Stamps, Messengers' Fares, and Parcels	138	6	2			
				3,236	16	2
,, Library, Bookbinding, etc.				67	18	8
,, *Journal*, including Printing and Publishing				1,547	11	11
,, Advertisements (Agents and Printing)				58	14	6
,, Examinations				3,262	11	4
,, Medals:—						
Albert	20	13	0			
Society's	6	6	6			
				26	19	6
,, Howard Trust				56	7	6
,, Fothergill Lectures				17	15	0
,, Aldred Trust				30	0	0
,, Donation to Board of Scientific Societies				20	0	0
,, Cantor Lectures				54	9	0
,, Sections:—						
Colonial	46	13	5			
Indian	67	5	7			
				113	19	0
,, Committees (General Expenses)				22	7	4
,, Purchase of £2,000 5 per cent. War Loan				1,900	0	0
				11,608	18	3
,, Cash on Current Account and on Deposit with Messrs. Coutts & Co., May 31st, 1917 (less cash in transit)				1,472	8	1
				£13,081	6	4

Liabilities.

	£	s.	d.	£	s.	d.
To Sundry Creditors	812	7	1			
,, Examiners' Fees	1,094	18	6			
,, Examination Medals	40	0	0			
,, Sections:—Colonial and Indian	100	0	0			
,, Accumulations under Trusts	283	0	3			
,, Loan from Messrs. Coutts & Co., for purchase of War Stock	1,900	0	0			
				4,230	5	10
,, Excess of assets over liabilities				20,492	2	8
				£24,722	8	6

Assets.

	Amount of Stock, etc. £	s.	d.	Estimated Value on May 31st, 1917. £	s.	d.	£	s.	d.
By Society's Accumulated Funds invested as follows:									
War Loan 5 per cent.	2,000	0	0	1,890	0	0			
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0	2,775	0	0			
Canada 3½ per Cent. Stock	500	0	0	360	0	0			
South Australia 4 per Cent. Stock	500	0	0	400	0	0			
N.S. Wales 3½ per Cent. Stock	530	10	1	456	5	0			
N.S. Wales 4 per Cent. Stock	500	0	0	415	0	0			
G. Indian Pen. Ry. 4 per Cent. Debenture Stock	217	0	0	158	8	0			
Queensland 4 per Cent. Stock	100	0	0	80	0	0			
Natal 4 per Cent. Stock	500	0	0	400	0	0			
Ground-rents (amount invested)	10,496	2	9	10,496	2	9			
Metropolitan Water Board B. Stock	321	15	9	196	6	0			
New River Co. shares	6	0	0	6	0	0			
India 3½ per Cent. Stock	3,408	14	6	2,317	18	8			
	22,080	3	1				19,951	0	5
,, Subscriptions of the year uncollected				582	0	0			
,, Arrears, estimated as recoverable				227	0	0			
							809	0	0
,, Property of the Society (Books, Pictures, etc.)							2,000	0	0
,, Advertisements due							90	0	0
,, Cash on Current Account and on Deposit with Messrs. Coutts & Co., May 31st, 1917 (less cash in transit)							1,472	8	1
,, Do. on Deposit (against interest on Trusts)							400	0	0
							£24,722	8	6

Funds held in Trust by the Society.

	£	s.	d.	
Dr. Swiney's Bequest	£4,477	10	0	Ground-rents, chargeable with a sum of £200 once in five years.
John Stock Trust	66	13	4	4½ per Cent. War Stock, chargeable with the Award of a Medal.
Benjamin Shaw Trust for Industrial Hygiene	88	17	10	,, ,, ,, of Interest as a Money Prize.
North London Exhibition Trust	128	1	4	,, ,, ,, ,,
Fothergill Trust	258	14	2	,, ,, ,, of a Medal.
J. Murray and others, in aid of a Building Fund	57	8	4	,, £36 12s. 0d. and India 3½ per Cent. Stock £20 16s. 4d.
Subscriptions to an Endowment Fund	374	14	10	,,
Dr. Aldred's Bequest	146	14	10	,, chargeable with the Award of a Prize.
Thomas Howard's Bequest	571	0	0	Metropolitan Railway 3½ per Cent. Preference Stock, chargeable with the Award of a Prize.
Dr. Cantor's Bequest	648	19	7	Bombay and Baroda Railway Guaranteed 3 per Cent. Stock } Interest applied to the Cantor Lectures.
	3,273	16	6	India 3 per Cent. Stock
	2,695	11	3	Ground-rents
Owen Jones Memorial Trust	522	3	2	India 3 per Cent. Stock, chargeable with the Award of Prizes to Art Students.
Mulready Trust	105	16	0	South Australia 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
Alfred Davis's Bequest	1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock. Interest at the disposal of the Council for promoting the objects of the Society.
Francis Cobb Fund	255	14	1	New South Wales 3½ per Cent. Stock.
Le Neve Foster Prize	105	11	7	3½ per Cent. War Stock, chargeable with the Award of a Prize.
	40	0	0	4½ per Cent. War Stock.
Amount to cover accumulated Interest on Trust Funds	400	0	0	On deposit with Messrs. Coutts & Co.
	£16,170	6	10	

TOTAL OF INVESTMENTS, ETC. (FACE VALUE), STANDING IN THE NAME OF THE SOCIETY (INCLUDING SOCIETY'S ACCUMULATED FUNDS AND TRUSTS AS ABOVE).

Ground-rents (amount of cash invested)	£17,669	4	0
War Stock 5 per Cent.	2,000	0	0
War Stock 4½ per Cent.	1,140	8	4
War Stock 3½ per Cent.	105	11	7
Metropolitan Railway 3½ per Cent. Preference Stock	571	0	0
Bombay and Baroda Railway Guaranteed 3 per Cent. Stock	648	19	7
India 3 per Cent. Stock	3,795	19	8
India 3½ per Cent. Stock	3,429	10	10
Canada 3½ per Cent. Stock	500	0	0
South Australia 4 per Cent. Stock	605	16	0
New South Wales 3½ per Cent. Stock	786	4	2
New South Wales 4 per Cent. Stock	500	0	0
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Queensland 4 per Cent. Stock	100	0	0
Natal 4 per Cent. Stock	500	0	0
Newcastle-on-Tyne 3½ per Cent. Stock	3,000	0	0
Metropolitan Water Board B. Stock	321	15	9
New River Company Shares	6	0	0
Cash on Deposit with Messrs. Coutts & Co.	400	0	0

Society's Accumulated Funds	22,080	3	1	£38,250 9 11
Trust Funds held by Society	16,170	6	10	

The Assets, represented by Stock at the Bank of England, and Securities, Cash on Deposit, and Cash balance in hands of Messrs. Coutts & Co., as above set forth, have been duly verified.

WILLIAM H. DAVISON
CARMICHAEL THOMAS } *Treasurers.*

H. T. WOOD, *Secretary.*

KNOX, CROPPER & CO., *Auditors.*

Society's House, Adelphi, 20th June, 1917.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Sixty-third Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' Statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Fellows, will be held, in accordance with the By-Laws, on Wednesday, June 27th, at 4 p.m.

(By order of the Council),

HENRY TRUEMAN WOOD, *Secretary.*

EXAMINATIONS.

The results of the Stage I. (Elementary) Examinations, which were held from March 26th to April 2nd last, were sent to the centres concerned on the 19th inst. The results of all three stages of the March examinations have now been made known.

In the Advanced Stage, 615 papers were worked. First-class certificates were awarded to 104 papers, second-class to 257, and 254 failed to pass.

In the Intermediate Stage, 2,566 papers were worked. First-class certificates were awarded to 421, second-class to 1,333, and 812 failed to pass.

In the Elementary Stage, 6,603 papers were worked. The number of passes was 4,211 and the number of failures 2,392.

LABOUR ECONOMY.*

By W. L. HICHENS,

Chairman, Messrs. Cammell Laird & Co., Limited.

In these days economy is uppermost in the mind of everybody. Economy in clothes, economy in locomotion, economy in all the luxuries and even the necessaries of life; but, above all, economy in food is the paramount consideration. We talk of little else but our rations, and sometimes one is tempted to think that the laudable ambition of everyone to economise dissipates itself largely in talk. For one reads in the papers with shocked surprise that, in spite of all our virtuous resolutions, in spite of the exhortations of the Food Controller and his legionary myrmidons, the consumption of bread has actually increased beyond the normal average, and one is tempted to say in one's haste

* Address delivered at the National Economy Exhibition Cutlers' Hall, Sheffield, on May 15th, 1917.

that "all men are food-hogs." How is it, one asks, that the self-denial of so many people that one knows of and the wordy protestations of countless numbers have produced so poor a result? Our hasty cynicism appears to be justified, and yet it is really a very ignorant piece of criticism. The fact is that Englishmen are very slow at the "uptake"; they are tardy in translating their words into deeds; they have a high personal co-efficient, in the language of physiologists. The will precedes the deed by more than a little, and yet the deed will surely follow.

Englishmen are proverbially slow in changing their ideas or their habits, possibly owing to their natural characteristics, possibly because England is an old country walled round with the white cliffs of prejudice and tradition.

No one who has lived in the British Dominions overseas can fail to compare the stolid opposition to new ideas which is characteristic of this country with the readiness to consider any new proposal on its merits which is a distinctive feature of Canada, Australia, and South Africa. It has been my good fortune to spend some years of my life in South Africa, and I have paid two interesting, though brief, visits to Canada. What struck me most in both these Dominions was that if any suggestion was made the minds of men at once set to work to see how it could be carried out, whereas in this country attention is at once concentrated on the objections. The one view-point is constructive; the other critical. In Sir Roger de Coverley's words, "There is much to be said for both sides," but I venture to think that in times such as those that we are now passing through the balance of argument lies with the doer rather than the critic. The worst mistake that can be laid to anyone's door is that he has never blundered, for in this fallible world the man who succeeds is the man who knows how to turn his mistakes to best advantage. And so I do not think we must be disappointed if the exhortations to food economy have hitherto met with a small measure of success. We have mountains of prejudice to remove first, and we know that mountains cannot be removed without faith. We have first of all to convince people that there is a real need for food economy and that the Government is not merely "bluffing"; and, in the next place, we have to bring it home that A's greediness or indifference is no justification for our own. But this takes time, and, if I may venture a criticism, it is that the food economy campaign hitherto has been insufficiently organised. We need to take to heart the brilliant example that has been set us by Keighley. The will is there, but it cannot be accepted for the deed, and if it is to be translated rapidly into action in England, a great and carefully organised "push" is needed, for we have to overcome, not merely the prejudices which I have mentioned, but one which is even more characteristic of us as a nation. Englishmen have naturally a generous outlook upon life; John Bull is always depicted as a stout good-natured individual with large pockets which he is always ready to unbutton. We admire generosity and despise anything that savours of meanness, thus following faithfully in the steps of our mother—Nature. Hence, when we are told that we have to exercise an economy which amounts, according to our old standards, to cheese-paring and are thought virtuous if we live off the smell of an oiled rag—a condition which in the past we associated contemptuously with less fortunate races—we feel, not unnaturally, that the ground is crumbling beneath our feet. It is a hard thing that we are asked to do—but we shall do it—and it is all the harder because it is unostentatious and even sordid. Naaman, the Syrian, found it very difficult to place great faith in the humdrum act of bathing in the insignificant Jordan, and the humanity of Naaman lives on.

But if it is hard to enlist the sympathy which expresses itself in action in the matter of food economies, it is far harder to translate any proposals for economy in labour into action; and yet important — even essential — though the former is, the need for the latter is yet more vital if we look beyond the present into the future. For it is no exaggeration, I think, to say that our whole economic future is bound up with labour economy; we shall stand or fall according as we embrace new ideas or adhere obstinately to the narrow prejudices which are milestones on the road to destruction. Our commercial supremacy was seriously threatened before the war, and it is certain that the assault will be continued with renewed vigour when peace is declared. A well-considered tariff may protect us from the unfair competition of dumping or may serve to nurse a young and growing industry to maturity, but we shall assuredly find that we have been living in a fool's paradise if we imagine that a tariff is a panacea for all our commercial difficulties. Success or failure must in the long run depend on our own efforts, on our initiative, adaptability, and energy—and it is right that this should be so, for it is right that the best man should win. All we are justified in expecting is a fair field and no

favour, and that is in fact all we need to ask for. As a nation we are pre-eminent in the qualities that make for commercial success, and we have only to see that they do not become overgrown with the moss of disuse. "Perseverance," as Shakespeare tells us,

"Keeps honour bright; to have done is to hang,
Quite out of fashion, like a rusty mail
In monumental mockery."

The long period of our unchallenged commercial supremacy has relaxed our vigilance; we have fallen into the bog of inertia, and it is no easy matter to scramble out again.

We have to face the fact that all waste in the production of manufactured goods must be as rigidly prevented as extravagance in the use of our food supplies. This will appear to everyone an obvious platitude, and yet a moment's reflection will show that it is largely ignored in practice.

It is not merely in minor matters that we are extravagant, although the little economies that might easily be effected would aggregate a large figure. The savings that any large firm could make in lubricating oils, fuel, electric power, lighting and tools, for example, if everyone concerned took a personal interest in checking waste, would secure many an order to this country which under present conditions goes to the foreigner. But it is, of course, visionary under present conditions to expect that the great majority of the employees in any big firm will take a keen personal interest in trying to save money for their employers. They are completely indifferent because they have no sense of loyalty to the firm they work for, and their standard of duty does not prompt them to treat its property with the same care as if it were their own. Perhaps the employer has only got himself to thank for the small measure of solicitude for his interests that is meted out to him; and perhaps, even if this were admitted to be so, it would nevertheless be true that two wrongs do not make a right. But I am not concerned with the rights and wrongs of the case for the moment; I merely wish to indicate one direction in which economies might be effected if everybody pulled together to one end.

But now let us take a larger field for saving. Most people nowadays are familiar with the principles of scientific management so ably worked out by Mr. Frederick Winslow Taylor and Mr. F. B. Gilbreth. We know how the former succeeded, at the Bethlehem Steel Works, in increasing the output of the pig-iron handlers from $12\frac{1}{2}$ to $47\frac{1}{2}$ tons a day—while at the same time reducing the working hours—by careful selection of the men and by a detailed scientific study of the motions involved in lifting and carrying a given weight of pig-iron. We know, too, how Mr. Gilbreth succeeded in reducing the movements involved in laying bricks from eighteen to five, and how his selected workmen averaged 350 bricks per man per hour, whereas the normal speed was 120 per hour. He practically trebled their efficiency. Mr. Taylor, indeed, instances one city in which the Bricklayers' Union restricted their men to 275 bricks a day when working for a public body, and 375 when working for private employers. In other words, Mr. Gilbreth's trained men could do in about an hour what was recognised elsewhere as a day's work.

Here, then, are enormous possibilities for economy in labour, not necessarily, let me add, in the payment for labour, which is a very different thing—but of that later.

It is well known that even before the war there was a great shortage of housing accommodation in England. This condition has since become much aggravated, and one of the first acts of reconstruction must be a comprehensive building programme. If a small part only of the economies suggested by Mr. Gilbreth were realised it would be possible to relieve the congestion in a comparatively short time, to provide cheaper and better houses, and at the same time to pay much higher wages to the building trade while giving them shorter working hours.

Surely a system that holds out such possibilities deserves more serious consideration than it has received in this country.

The difficulties are fourfold. In the first place it smacks of novelty, and is therefore met with all the critical hostility that I have referred to before.

In the second place, the introduction of new machinery and new mechanical devices is opposed because, although they may effect great economies, yet they may and often do cause serious hardship in individual cases by throwing men temporarily, at any rate, out of work.

In the third place, it is popularly supposed that this system reduces workmen to the position of slaves or machines—perhaps mechanical slaves. I remember hearing Miss MacArthur describe the experiences of a labour emissary who was sent to the United States to study labour conditions there, and this system amongst others. The emissary was taken to a factory where the system was in operation, and was

particularly struck by one man whose whole soul appeared to be absorbed in his work. "That man," said the manager, "is the best workman we have got, and"—he added thoughtfully—"he is a congenital idiot." One cannot really blame the system because a congenital idiot can excel under it, and there is no evidence to show that purely routine work tends to convert people into idiots; but there is force in the point that routine work has often little educational value, and ideally all work ought to be educative. It seems to me, however, that this fault is inherent in all organised existence, and that it is only possible to substitute more and more mechanical for human labour, to improve the opportunities of those who are fitted for more intelligent work, and to raise the external conditions of the purely unskilled workman. It is wholly untrue, however, to suppose that to throw all one's energy into one's work and study to do it scientifically is less educative than to do it in a haphazard and half-hearted fashion.

But the fourth difficulty is the greatest. Scientific management implies that restriction of output shall be abandoned, for it presupposes that everyone will do his best. There is no doubt, I think, that by far the greatest menace to the future prosperity of this country is the restriction of output, which eats like a cancer into the industrial organism. It is easy enough to diagnose the general causes of the disease and to point out that it is bound to be chronic so long as labour has no assured and reasonable share in the increased wealth that it produces. It is easy enough, too, to agree that labour ought to have such an assured and reasonable share; but when we descend from the general to the particular, it is a matter of very great difficulty to work out the basis on which a fair distribution of wealth can be made. Perhaps there is no perfect system; perhaps at most we can only hope for a rough-and-ready scheme which will be recognised as a substantial improvement on present conditions. This much is certain: that if labour and capital could compose their differences and really pull together, the results that might be achieved are staggering. Imagine a football team in which every member played as slackly as he dared; in which the forwards were jealous of the half-backs, and the halves of the three-quarters; where no one trusted the captain, and where any section of the team was ready to stop at any moment during the progress of the game while the enemy scored goal after goal, in order to emphasise a real or imaginary grievance. Such a team would be hooted out of existence; it would be covered with ridicule and ignominy. And yet it is just such a team which is trying to run the industries of this country. We can organise for games and practise all the principles that make for organised efficiency. Is it impossible for us to apply those principles to the serious pursuits of life?

It is probably no exaggeration to say that if capital and labour worked together as loyally as the members of a football team, our national income could be doubled in a few years. Before the war the annual national income was estimated at £2,000,000,000, and it is obvious that the addition of a like sum annually would render possible the most far-reaching reforms. It is surely far more sensible to combine in the creation of new wealth than to dissipate what already exists by quarrelling over its possession.

This, again, seems an obvious proposition, but I do not think we can hope for any permanent improvement in the matter of labour economies at the present time. We have mountains of distrust and abuse to remove before any real progress can be made. Just as in the far less controversial and less difficult case of food economy, it takes a long time and careful organisation to secure results, so no big labour economies will be effected unless the question is taken up and treated as one of national importance. As a first step, therefore, it is important to emphasise the enormous scope for improvement that exists, and to show how great is the stake from the national point of view for which we are playing. If this is realised, I believe that British commonsense will assert itself, and that some practical working hypothesis will be found whereby the full fruits of industry can be reaped and shared by all.

INDIA'S COAL SUPPLIES.

Attention is drawn by the *Pioneer Mail* to the Report on the Production and Consumption of Coal in India, recently issued by the Department of Statistics. The report is summarised as follows:—

For the years 1878–1880 the average annual output of the Indian collieries was less than a million tons, whereas in 1915 the total was more than seventeen times that figure. Within the past ten years the expansion has been most marked, the output of 17,104,000 tons in 1915 comparing with a production of 8,417,000 tons in 1905. India has now to rely entirely on her own coal resources, for while in the nine months, April to December, in the year immediately preceding the war, the imports amounted to

445,000 tons, the receipts from abroad in the corresponding period of last year were no more than 23,525 tons, of which 1,199 tons only were drawn from the United Kingdom, the balance being imported from Natal, Australia, and Portuguese East Africa. The quantity of coal exported from India during the nine months ending with December last was 661,031 tons, and of this 386,692 tons went to Ceylon and 128,000 tons to the Straits Settlements.

With the extension of railways and the development of industries, there has been an enormous increase in the consumption of coal in India. Precise information respecting this consumption is not available, but an estimate places the total for 1915 at 16,541,000 tons, of which the railways absorbed 5,187,000 tons. The estimate for the railways, however, relates to the official year 1915–16. The consumption by jute mills in 1915 is estimated at 886,000 tons, by cotton mills at 1,121,000 tons, by iron and brass foundries at 1,332,000 tons, and by brick and tile manufactures at 1,197,000 tons, while bunker coal is stated at 868,000 tons. Other large consumers are inland steamships, which, according to the estimate, took 619,000 tons, and tea gardens, which consumed 165,000 tons. Consumption at the collieries and wastage are computed to have accounted for a further 1,710,000 tons, leaving a balance of 3,296,000 tons for other forms of industrial enterprise and for domestic purposes. There are no data for forming an estimate as to the distribution of the last-named total. "Cotton presses and jute presses," says the report, "doubtless account for a considerable proportion. Excluding indigo factories and premises used for the purposes of tea and coffee plantations, there are, in addition, many other factories worked by steam and a considerable number of other concerns too small to be included in the factories' return. Many of these concerns use fuel other than coal, wholly or in part, but it may safely be assumed that the greater portion of the balance of 3·3 million tons of coal is to be debited to industrial consumption, and only a small part to domestic consumption." The committee recently appointed to regulate the coal supplies is collecting information from consumers of coal, so there is reasonable ground for assuming that more definite data will be available regarding the whole subject.

No less than 85·5 per cent. of the entire coal output of India is now raised in the Raniganj and Jherria fields, the production of the former in 1915 being 5,485,000 tons and of the latter 9,141,000 tons. Of the total mining population, moreover, numbering 160,086, over 137,000 were employed in the collieries of Bihar and Bengal. The question of the labour supply presents difficulties which are not encountered in countries where mining is a special calling. The majority of the persons working at the Indian mines are agriculturists, and the supply of labour, as experience has recently shown, depends to a material extent on the condition of the agricultural industry. "The major portion of those employed," the report remarks, "are the aboriginal Dravidians from the mountainous country of Chota Nagpur and the Central Provinces, but a large number of other castes is also employed, particularly in the outlying fields. The majority of the workmen follow the vocation of agriculture as well as mining, and return to their homes during the period of sowing and reaping, the result being that at such times the output of many of the mines is greatly restricted. At the Makum collieries of the Assam Railway and Trading Company, where the labour question continues to be a very difficult one, nearly a third of the total labour force are Mekranis, Chinese, and Nepalese. The Chinese have, however, proved unsatisfactory, and it is unlikely that they will in future be recruited." With the increase in the depth of working the need for a skilled mining class will become accentuated, and if the price of coal remains at a sufficiently high level, further development in the introduction of coal-cutting plants may take place. During the period of high prices some nine years ago cutting plants were introduced in order to augment the output. These worked successfully, but the cost proved to be high and as labour conditions improved the machines were discarded. Whatever the innovations to be introduced in the future, there is cause for profound satisfaction in the fact that India is in a position to produce so large a quantity of a product without which modern industry could not exist, and the experience gained during the war should lead to greater attention being devoted to the mineral wealth of the country and the creation of industrial enterprises which will reduce the dependence of India on the works and manufactories of foreign countries.

FRUIT BOTTLING.

The following notes are taken from a leaflet on "Fruit Bottling for Cottagers," issued by the Royal Horticultural Society:—

It is important to secure a good supply of suitable bottles before the fruit season comes. The right bottles should have, first, an indiarubber band which lies flat on the rim of the bottle; secondly, a flat glass lid which lies on the rubber ring; and thirdly, a metal screw which fits over the neck of the bottle and over the glass lid and screws down tight on to the glass lid, settling it down firmly on the rubber ring and so making the bottle air-tight.

The bottles once purchased will (if taken care of) serve well for very many years to come, although the rubber ring may want renewing every fourth or fifth year.

The bottles should be thoroughly cleaned and

dried. Glass vessels of any sort should not be put when cold into hot water, or when they are hot should not be put into cold water or even placed on a cold surface such as a stone slab, or on bricks. The very smallest crack in the bottle may make the whole contents go rotten.

The fruit should be picked when it is just ripe and no more. It should be cleaned and dried, and packed closely in the bottles, which should be quite full. Apples and pears should be cut in quarters; all other fruits should be put in whole. The bottles should then be filled with clean warm water, the rubber ring and the glass lid should then be put on, and next the metal rim placed loosely over them. It should not be screwed down tight at present. The bottles should be placed up to their necks in cold water in a fish kettle or open boiler, which should have a false bottom so as to prevent the bottles standing on the thin metal bottom of the kettle, which gets so hot as occasionally to crack the glass. A little hay should be put round the bottom of the bottles to prevent their hitting one another when the water boils, and so getting cracked. The water in the kettle should be brought very slowly to the boil, and then allowed to boil for 15 or 20 minutes. Then each bottle should be taken out separately, and without a moment's delay the metal rim should be screwed down tight upon the glass lid and rubber ring below it, whilst the water in the bottle is at boiling heat. The neglect to screw the lid down tight immediately the bottle is taken out of the kettle is at the bottom of almost all failures.

Gooseberries, raspberries, currants, plums, damsons, blackberries, apples, pears, and most other fruits may be preserved in this way. Strawberries are not recommended.

The contents of the bottle can be used in any way in which fresh fruit is used, by cooking it in pudding or pies, or by stewing it with a little sugar.

CHINESE BLACKWOOD.

For the manufacture of the so-called "blackwood" furniture the Chinese employ several distinct species of timber, the botanical identity of which has hitherto been a matter of some uncertainty. The blackwood is imported into China chiefly from Bangkok and Saigon, but some forms are also imported from Java. It is not possible to state definitely the amount of blackwood annually imported into China, as this is not separately recorded in the Chinese Maritime Customs Returns of Trade, but the imports of hardwood (exclusive of sandalwood) into China during the years 1913–15 indicate the importance of the trade in hardwoods. Some information relating to the blackwood exported from Siam to China has been obtained from a memorandum on the subject recently received at the Imperial Institute from H.B.M. Consul at Bangkok. Blackwood occurs in India and the Malay Peninsula, and it would, therefore, appear worth while for Indian and Malayan exporters of timber to give some attention to the Chinese market.

In Siam the rosewoods are worked more particularly from the regions lying north-east and east of Bangkok. They are exported in the form of roughly-trimmed round logs, of average size from 1 to 2 ft. in circumference, and from 6 ft. 8 in. to 10 ft. in length. The timber could probably be obtained in slightly larger logs, but, owing to its great weight, the size mentioned appears to be the largest that the Siamese villagers can conveniently handle and transport. Further, as this timber is employed by the Chinese almost entirely for furniture-making, a demand for larger pieces does not appear to have arisen. The Siamese rosewood forests have been heavily overworked in the past. The species of *Diospyros* that yield the ebony woods are found to the westward of Bangkok, in the districts of Kanburi, Petchaburi, and southwards towards the Malay Peninsula.

The extraction of these woods is not a regular industry anywhere in Siam, but forms one of the desultory occupations of the people when they are not engaged in rice cultivation. The wood is bought from the natives by the Chinese, who are either middlemen or the agents of Chinese firms in Bangkok. The blackwoods are too heavy to float, and are therefore brought down to Bangkok either by boat or rail. They are sold by weight, the unit for export being usually 100 piculs, and the average prices £22 10*s*. to £37 10*s*. per unit for rosewoods and about £22 10*s*. for ebonies. The price for rosewoods varies according to the size of the log, the age of the trees, and the fineness of the grain. The furniture made for the Chinese home market is not so elaborately carved as that intended for export to Europe, but great importance is attached to the finish and polish of the wood and also to its colour and uniformity of grain. In the furniture made for the European market the wood is stained black and waxed so that the original colour is completely hidden. Examples of Chinese blackwood furniture are exhibited in the Hong-Kong Court of the Public Exhibition Galleries at the Imperial Institute.—*London and China Telegraph*.

PRODUCTION OF SUGAR IN PERU.

Recently published statistics on the production of sugar in Peru show that in 1914 the average production per hectare of 2·471 acres was 10·193 metric tons (of 2204·6 lb.), equivalent to 4·547 short tons per acre, while in 1915 this average had increased to 10·378 tons (4·629 short tons per acre), due, no doubt, to the introduction of improved machinery on several of the larger plantations. In the Santa Valley, where the production of cane per hectare is as good as, or better than, that of many other sugar regions of Peru, the sugar

yield is but 7 metric tons per hectare (3·123 short tons per acre). This is probably due, says the United States Commercial Attaché at Lima, to the fact that in the Santa Valley there is still being used an old mill which was erected in 1874, and which has been but little improved since that date. In the Chicama Valley, where are located the fine modern mills of Casa Prande, Cardavio, and Laredo, the production reaches the unusual figure of 13·506 metric tons per hectare (6·025 short tons per acre).

The area suitable for the growing of sugar cane on the west coast of Peru is limited only by the available supply of water for irrigation. It is understood that several projects for the irrigation of sugar lands are being studied, especially in the Santa and Jequeteneque valleys; while in the Chicama Valley the supply of subterranean water has been tapped, and the use of centrifugal pumps for bringing it to the surface has made it possible to increase the area under cultivation.

During the years 1914 and 1915 the sugar of Peru was disposed of to the following countries in the proportions indicated:—

Destination.	1914.	1915.
	Per cent.	Per cent.
Chile	29·51	35·93
United States . .	9·99	21·69
Great Britain . .	29·30	17·80
Canada . . .	6·65	...
Spain	...	4·17
Bolivia	1·02	1·68
Consumed locally or stored . . .	23·53	18·73
Total . .	100·00	100·00

An official review of the sugar industry of Peru for the five years 1911–15 discloses an advance of 47 per cent. in production and one of 78 per cent. in exports during the half decade. The figures are:—

The exportation of such a large proportion of the total production (69 per cent. in 1911, 76 per cent. in 1912, 77 per cent. in 1913 and 1914, and 84 per cent. in 1915) has led to efforts by the Constitutional Party to secure legislation limiting the shipment of all kinds of sugar to 75 per cent. of the annual output, it being claimed that 66,000 metric tons a year are needed for domestic consumption. (This is more than 2 ounces a day per caput on a basis of 3,000,000 population.) It is thought that such action would result in the lowering of the present high price of sugar in Peru.

THE CENTRAL CAUCASUS.

In an article on the Central Caucasus, which appears in the *Scottish Geographical Magazine*, Mr. Harold Raeburn gives an interesting account of the province which has been described as "Russia's Pearl."

In Caucasia as a whole, he writes, every product from arctic to tropical can be grown. In Central Caucasus, which rarely falls below 2,000 feet, the sub-tropical climate of lower Trans-Caucasia does not, of course, exist. Many vineyards are met with both near Vladikavkaz and at Oni, and maize is also very extensively cultivated, while fields of sunflowers, square miles in extent, may often be seen. The seeds are used for food as well as for oil. The vineyards of the Caucasus are probably greatly under-estimated at 350,000 acres, and Russian vineyards certainly well exceed 1,000,000 acres. The wines of the Caucasus, though rather rough and strong, are often excellent. The commoner kinds have, however, usually a distinct smack of paraffin. The usual vessel for storage and transport is, as in Spain, the skin of an animal. In the Caucasus this is treated or cured with petroleum, and the flavour is very persistent.

The huge fields of maize, often miles in extent, are quite unfenced, and persons driving through make their way between the great stalks and let their horses eat their fill, besides carrying off a stone or two of the huge sweet unripe cobs to eat themselves on the journey or at home.

Wheat, barley, rye, and millet are also abundant crops. Fruits of all kinds grow well. Potatoes are still somewhat scarcer than one would expect in

Year.	Production in Metric Tons.				Exportation in Metric Tons.			
	White and Granulated.	Muscovado.	Chancaca.	Total.	White and Granulated.	Muscovado.	Chancaca.	Total.
1911	128,071	21,936	1,026	(a)178,533	104,763	18,927	...	123,690
1912	(b)	(b)	(b)	192,754	(b)	(b)	(b)	147,410
1913	153,568	28,775	1,611	183,954	121,031	20,495	1,375	142,901
1914	200,005	27,492	557	228,054	152,381	24,026	263	176,670
1915	232,616	28,259	1,965	262,840	195,100	24,227	930	220,257

(a) Includes 27,500 tons of sugar, the estimated production of those estates that did not furnish returns for 1911.
(b) Data not available.

the high valleys. They are also very late, for in August they had only reached the size of beans. Wild fruits, such as red currants, raspberries, strawberries—very large but varying curiously in flavour—cherries, and plums, as well as bilberries, are everywhere met with in the high valleys. They are greatly sought after and appreciated both by the people and by the bears.

Minerals.

Gold undoubtedly exists. Much more has been spent in looking for it than has been found. The Rion River is, of course, the ancient Phasis, where the ancient Greeks used to obtain gold from the shepherds. These shepherds were in the habit of placing sheepskins loaded with stones in the torrents for some time. They then burned these, and sold the gold thus caught to the Greeks. Hence the legend, like most legends strongly founded on fact, of the "Golden Fleece." Alexander the Great was said to have had a mint on the upper Ingur. In 1913, while at Betsho, I was offered three gold pieces rather larger than our sovereign. These were said to be part of a lot of sixteen found by some people who were digging a grave. These were beautifully executed and in perfect preservation. They did not look as if they had ever been in circulation. The monarch was undoubtedly Alexander the Great. They were valued at Rs. 1,000 (equals rather over £100) by the seller, so no sale was made. They may, of course, have been forgeries.

Iron, lead, silver, and copper also occur. Silver-lead ores are extensively worked in the Sadon Valley, off the Mamison Road. The copper mines were mostly closed in 1913-14, the cost of transport and labour being too high.

Mineral springs are very abundant on the south side of the chain. Of course, the "Bath Towns" round the "Five Hills" on the north side are famous health resorts known all over Russia. Special fast expresses run to Mineralnaia Vodi Junction from Petrograd, Moscow, and Kieff throughout the summer. Great numbers of highly aerated ice-cold springs of pleasantly acidulated ferruginous water bubble up in most of the Asian valleys. Our party drank of one of these which issued from below the moraine of the Nuamkuam glacier before making the ascent, the first of that mountain (14,200 ft.). The people, their animals, and also the mountain goats (tur) and chamois, greatly like them also.

Forests.

The steppe is practically treeless, except for the trees planted round farms or a few along the river banks, though great tracts of forest still exist in the hills up to 8,000 ft. The last stragglers are generally specimens of *Pinus nordmanni* at between 7,000 and 8,000 ft. The prevalent tree at moderate elevations, both on the north and south side of the central axis, is the beech; higher up occur poplar, maple, birch, pine, and fir. The birches and poplars grow to a great size in Suanetia.

The Romans are generally credited with the destruction of the forests of ancient Caledonia to deprive the wild tribes of cover. Russia, no doubt, has denuded certain parts of the Caucasus of its timber for a similar reason; but the natives themselves are most wasteful and destructive. In 1913 our party, when camping high at night, several times witnessed forest fires burning on the distant foothills. Our native cook (an Imeritian) was never so pleased as when he could get a fire going of the largest logs he could move—of course, of dead wood. A very destructive system is that of heavily gashing the firs and pines for the purpose of collecting resin. It does not pay usually to cut the trees owing to cost and difficulty of transport. This resin-cutting is now said to be put a stop to in the Government-controlled forests. In certain places also wood-rangers have been put on to see that the natives do not wantonly destroy the timber.

The peace and security of the high valleys has, curiously enough, a very bad effect upon the vegetation near its limits. Sheep, and especially goats, have increased, and those are not so carefully watched and limited as of old. Goats are more deadly enemies of forests than Romans, Russians, fire or flood.

There is no doubt that tree-killing is responsible for the increasing severity and destructiveness of the river-flooding on the steppe. The country is so new, geologically speaking, that the rivers which issue from the foothills on the north have not yet cut deep channels in the alluvium. The sudden check in their fall causes the deposition of the glacier silt. The river often spreads out into several channels, and these shift with every flood, so that it is not much use building bridges. A bridge built one year may be high and dry the next, the river having shifted half a mile away. The suddenness and violence of the flood is, of course, greatly increased by the loss of the rain- and soil-holding trees. In forest conservation and propagation lies the remedy. The Russian Government have great difficulties with the proprietors and villagers in the upper reaches, who never plant, want to cut down as many of their trees as they choose, and say they have no interest or concern with what happens lower down the river.

Domestic Animals.

The chief exports of the mountains are live-stock, horses, sheep and cattle, in order of importance. The mares are turned out free on the pastures above tree-level all summer. They come down with the snows, and the surplus are driven to the low country for sale.

Cows, for some reason, probably the trouble of keeping them in winter, are very scarce. It is seldom possible to obtain any milk, unless sometimes that of the goat, in the mountains. Fowls are everywhere numerous, and eggs are a commoner currency than coin in some parts. The price to us in 1913 was usually two kopäyks each = ½d. The Princess of Suanetia informed us, however, that

between natives the standard price was one kopāyk. In 1914 I have managed to obtain them at that price = four a penny. Though small, not one bad egg was ever sold to us in either 1913 or 1914.

The sheep are small, often black in colour; their price as they stood was from four to five roubles = eight to ten shillings.

Future Development.

The—mostly mountain—land dealt with in this paper can never be a rich country. There is little or no coal, though I observed shale very similar to Lothian shale in certain localities. We were offered iron mines, but these would require to be very rich to pay for working and transport. The country does possess, however, an enormous source of energy for electrical power in its numerous rivers, perennially full from the drainage of its billions of tons of "white coal" in the form of great glaciers and icefields. Natural points for tapping this are provided where the rivers pass through the limestone gorges of the foothills.

TRADE IN SOUTH AFRICAN BOX-WOOD REVIVED.

The revival of trade in South African boxwood after many years of inactivity is attributed to the war. Hitherto, says the United States Vice-Consul at Port Elizabeth, the European market has drawn its supplies from the forests of Turkey, Asia Minor, and the shores of the Black Sea. Previous to 1914 the annual shipments from Constantinople were from 5,000 to 7,000 tons.

The Government forests in the Alexandria district comprise an area of 2,177 acres, located on the coastal belt between Sunday's and Bushman's rivers. According to the statement of the District Forester, this tract will furnish 50,000 cubic feet of sound boxwood of 4 in. or more diameter. The percentage of bark to wood is 14·5, and the weight of the green wood per cubic foot is 79 lb. The average length of the boles is 5 ft. 4 in., and the average diameter 5·7 in.

In addition to the Government forest, a company has purchased the timber rights of several privately owned forests, and has engaged a force of a hundred men for cutting operations. Several sample consignments of 25 tons have been sent to London, and have found ready markets at prices varying from £9 10*s.* to £14 per ton. The Colonial boxwood, known in South Africa as *Buxus macowani*, is said to be equal to the Turkish and Persian varieties (*Buxus balearica* and *B. Sempervirens*). The wood possesses a delicate yellow colour, is very dense in structure, and has a fine uniform grain, which gives it a unique value for the purposes of the wood-engraver. In addition to the ever-increasing engravers' demand for boxwood, a large quantity is used in the manufacture of measuring rules, mathematical instruments, flutes and other musical instruments, for inlaying, and for small carvings.

DYEING MATERIALS IN THE PHILIPPINES.

In response to a demand for information regarding plants in the Philippine Islands yielding products suitable for dyeing purposes, a review of the subject has been prepared by the Philippine Bureau of Science.

There are sources of natural dyestuffs in the Philippine Islands, yet it is doubtful, the Bureau states, if they will attain much commercial prominence. Probably more than one hundred species of plants containing valuable colour principles are found in the Philippines, and many more undoubtedly could be readily cultivated. In many cases the colours produced are inferior in quality, being either fugitive or not clear. As the plants that yield dyeing materials grow wild and often are widely scattered, the supply is unreliable and insufficient. Little has been done towards developing the manufacture of local colouring materials, and until there is an intensive cultivation of the necessary plants, and the capital necessary for the enterprise can be secured, there is little prospect of commercial success.

Only two Philippine dye plants are commercially important. These are indigo and sappan or sibucao. Others are used locally, but scarcely enter into domestic commerce, much less into the external commerce of the archipelago.

Indigo (*Indigofera tinctoria*, Linn., and *I. suffruticosa*, Mill.), locally known as tayum, tayom, tagum, pouay, tayum-tayum, and tagung-tagung, has been in the past extensively cultivated in some parts of the Philippines, and the prepared product entered extensively into the export trade. With the development of the coal-tar dye industry and the manufacture of artificial indigo, however, the cultivation of indigo as a commercial crop in the islands practically ceased. Indigo is still cultivated on a small scale in some parts of Northern Luzon, but only to supply a limited local demand for blue colouring matter. It is possible that the extraction of natural indigo might be profitable at present, but the rehabilitation of the indigo industry would take time and a considerable investment of capital in extraction vats, with the practical certainty that at the close of the war the industry would suffer from the competition of coal-tar products.

Sappan or sibucao (*Cæsalpinia sappan*, Linn.) is a shrub or small tree, and is widely distributed in the settled areas of the Philippines at low and medium altitudes. It is not systematically cultivated, yet in a few districts, such as Guimaras Island and parts of Panay, it is found in great abundance. In general, it appears only as a widely scattered tree. It has valuable properties and yields a red dye. The wood is annually exported in considerable quantities to Southern China.

Exports of sappan wood from the Philippines to China (exclusive of Hong-Kong) in 1914 amounted to 1,515,756 lb., valued at £1,343, and to Hong-Kong amounted to 621,597 lb., valued at £586. During 1913 the exports to China (exclusive of Hong-Kong) amounted to 1,173,036 lb., valued at £907, and to Hong-Kong 1,358,258 lb., valued at £967. No exports to other countries are on record.

This wood yields about 2 per cent. of colouring material by extraction with water. For the export trade, the colour should be extracted from the wood and the water evaporated, thus reducing freight charges. A former member of the Bureau of Science has shown that this wood contains brazilin, the colouring matter found in brazil-wood. Brazilin is not a fast dye, and an objection to it is that it is very sensitive to acids and alkalis.

Brown dyes are obtained from numerous plants, chiefly from the shrub or small tree known as bancudo or nino (*Morinda indica*, Linn.), certain of the mangrove trees, such as ceriops and bruguiera, the bark of xylocarpus (tabigue or nigui), and from numerous others less important. Many of these barks are useful in tanning as well as dyeing.

Bancudo is the well-known al dye of India. It requires the use of a mordant, since it does not dye cotton directly. Cotton mordanted with tannin is coloured dark red with bancudo.

Black dyes are secured from *Heritiera litoralis*, Dry. (dongon late), a common coastal tree, and from some species of *Hibiscus*, *Semecarpus*, *Terminalia*, and *Diospyros*. The determining character in most cases is the presence of tannin in large quantities.

Yellow dyes of minor importance are secured from the seeds of *Bixa orellana*, Linn. (achuete); from the wood of *Nauclea* (baucal); from *Carthamus tinctorius*, Linn., which is occasionally cultivated as a dye plant; from the bark of the common mango; from some species of *Vitex* (molave); and from ligtang, a woody vine having yellow wood rich in berberine.

Berberine is found in several plants of the Philippine Islands. Cloth dyed with it does not show as bright a yellow as that dyed with turmeric, but it has the virtue of being much faster to light than the latter.

Turmeric (*Curcuma longa*, Lam.), locally known as dilao, is an herbaceous plant of the ginger family. The yellow fleshy rootstocks are utilised for dyeing yellow, but the colour soon fades. The plant does not occur in sufficient quantities in the Philippines to yield a useful supply of the rhizomes. However, its cultivation is a simple matter, and it can be propagated very readily. It is extensively cultivated in parts of India, but chiefly for its value as a constituent part of curry powder. In the Philippines it needs cultivation and exploitation to become of commercial importance.

Peristrophe tinctoria, Nees, an herbaceous plant widely scattered in the settled areas in the Visayan Islands and sometimes cultivated on a small scale, yields a beautiful red dye, which is locally used in the Philippines. The parts used are the tender shoots and young leaves. This material can be crushed in a mortar, and the resulting pulp dried and preserved for future use. It is very doubtful whether the plant can be obtained in sufficient quantities or whether its commercial utilisation is possible. It is known as deora, taoda, and calaora in Mindanao and Negros.

It is declared evident that the known dye plants of the Philippine Islands do not occur in sufficient quantity greatly to relieve the shortage in the dye supply. A study of the conditions in the United States, under which the manufacture of synthetic dyestuffs has been attempted, the lack of available raw materials, the large amount of capital necessary to start the industry, and the assured competition of European products after the close of the war, all are believed unfavourable to the development of the natural dyestuff industry in the Philippine Islands.

SALE OF GOVERNMENT FURS IN THE UNITED STATES.

According to a United States official report, at a recent public auction of furs in St. Louis, 1,900 dressed and dyed sealskins were sold on Government account. These were the first products of the newly established plant at St. Louis. There were also 420 blue fox skins and 20 white fox skins from the Pribilof Islands. These furs were part of a very large quantity of miscellaneous skins from all parts of the world offered for sale, and the sale attracted buyers from all parts of the United States and from five foreign countries.

The trade classifications of the sealskins, following the London standard, were: Middlings, 2; middlings and smalls, 27; smalls, 151; large pups, 640; middling pups, 900; small pups, 180. The skins were from male seals, mostly three years old, and none less than two years old. The prices received ranged from £7 to £10 per skin, and the gross proceeds were approximately £15,000. These figures, considering the small number of skins offered for sale, and the light demand owing to the practical absence of sealskins from the markets in recent years, are regarded as satisfactory. In the sale of fox skins no such record prices were obtained as in 1915. The best lots of blue foxes fetched £23, £25 10*s*., £26 and £27 per skin, the average being £11 18*s*. The white foxes sold for £2 18*s*. per skin. The Government's gross receipts from fox skins aggregated £4,100.

Following the actual enumeration of certain elements of the seal resorting to the Pribilof Islands in 1916, the United States Bureau of

Fisheries has made a tentative estimate of the other components of the herd, based on partial counts and on an assumed natural mortality, employing the same factors as were used in 1915. The computation is as follows: Breeding females, 116,977; pups, 116,977; harem bulls, 3,500; idle bulls, 2,632; yearlings, both sexes, 67,291; two-year-olds, both sexes, 48,460; bachelors and young bulls, 61,492; total, 417,329. The last three figures are subject to revision after a more careful study of the data on branded seals and other records. The total figures for 1915 were 363,872.

NOTES ON BOOKS.

INDUSTRIAL FATIGUE IN ITS RELATION TO MAXIMUM OUTPUT. By Henry J. Spooner, C.E. London: Co-partnership Publishers, Ltd. 6*d*. net.

A number of articles on industrial fatigue by Professor Henry J. Spooner recently appeared in *Co-partnership*, and they are now republished, with forewords from Sir Robert Hadfield, F.R.S., and Mr. J. R. Clynes, M.P. They give in a brief space an excellent summary of all that has been written on the relation of industrial fatigue to output. As Sir Robert Hadfield points out, it does not pay to work men for too long hours. At the outbreak of the war, owing to extraordinary pressure, his works, employing some 15,000 hands, never shut down, except for one or two holidays; they ran clean through for eighteen months without a stop from Monday morning until Sunday night. The effect of this terrible strain on human nerves can easily be imagined, and there seems to be little doubt that much of the industrial unrest prevalent at present is directly due to it.

One of the great problems of the near future will be how to maintain, or increase, the output of work while shortening the hours of labour. Professor Spooner draws attention to the steps taken by Mr. Frank Gilbreth and others in the direction of eliminating needless muscular motions. Some of the results achieved in this way are very striking. For instance, in bricklaying (to which reference is made by Mr. W. L. Hichens on page 547 of this *Journal*) the motions have been reduced from 18 to 5, and the output increased from 125 to 350 per hour; in cloth-folding 20 to 30 motions have been reduced to 10 or 12, and the output increased from 150 to 400 dozen, with no added labour; while a workman engaged in assembling braiding machines raised his output from 18 to 66 in a day, with no additional fatigue.

The pamphlet deals with a number of other interesting and important points, and contains *inter alia*, some useful suggestions in connection with the provision of suitable employment for disabled soldiers.

A GUIDE TO DRAUGHTSMANSHIP. By W. Horace Smith. London: E. & F. N. Spon, Ltd. 2*s*. 6*d*. net.

Like most of Messrs. E. & F. N. Spon's publications, this little handbook is practical and to the point. It is specially designed for the use of architects, civil and mechanical engineers and surveyors, and contains information on instruments and materials, tracing, colouring, lettering, etc. A number of plates are included, showing the conventional signs used to indicate such things as grassland, orchards, trees of various descriptions, quarries, chalk-pits, embankments, etc.

Unfortunately, like the writers of many technical books, the author is so intent upon his matter that he pays little or no attention to his style, with the result that we find sentences like the following: "This will be found to slightly tilt the edge against which you are drawing, thus (if using a pen) minimising the risk of the ink running under the square, and at the same time greatly facilitating the movement of same." Apart from the sheer ungainliness of the last two words, there is, grammatically speaking, nothing to show whether they refer to the square, the ink, or the pen.

GENERAL NOTES.

LACQUER INDUSTRY OF JAPAN.—The Japanese Economic Investigation Committee has been considering measures for promoting the lacquer industry in Japan. The demand for this product in Japan is increasing each year, and has attained an annual average of 260,000 kwan* during the last three years. Of this total 60 per cent. is for ordinary lacquered wares, and the remaining 40 per cent. for furniture, railway carriages, jinrickshaws, carriages, safes, musical instruments, etc. It is estimated that the total requirements of the country will soon reach 300,000 kwan annually. The aggregate output of lacquer in Japan in 1915 was valued at about 8,700,000 yen,† and this is expected to be increased after the war. Thirty per cent. of the quantity of lacquer consumed in Japan is produced at home, the remainder being imported from China. The lacquer trees of Japan are decreasing in number yearly. The number of such trees in 1901 was about 5,000,000, which fell to 1,200,000 in 1913, with a tendency to decrease further. The principal cause of this decline is believed to be the unprofitable results of planting, and also the system of monopolising the padding and sale of lacquer. The Government is urged to make further investigations with a view to promoting the industry in Japan.

* 1 kwan = 8·3 lb. † 1 yen = about 2*s*.

German "Substitute" Soap.—A great deal is heard of the German aptitude for inventing substitutes, in order to minimise the inconvenience caused by our blockade and the shrinkage of Germany's natural resources. These substitutes, however ingenious, are not always satisfactory, and attention is drawn by *Engineering* to a case recorded in the *Zeitschrift des Vereins deutscher Ingenieur*, where unexpected trouble has been caused by the use of soap substitutes. These consist of preparations made from precipitated clay, China clay, and slaked lime, which, while they are said to be fairly efficient substitutes for soap, seriously impede the domestic drainage system. It has frequently been found that the house mains become obstructed, particularly at the point of junction with the street mains, by a white, pasty sediment, and the only remedy in most cases is the laying bare and opening of the drain pipes to remove the obstruction. The mass thus removed is found to consist of clay and lime mixed with fibrous matter of vegetable nature, which consolidates into a tough paste. In order to prevent the nuisance it has been suggested to the householders that slops should not be emptied into the drainage system till the remainder of the sham soap has accumulated at the bottom of the pail—an instruction which the average domestic would, of course, religiously observe.

Cost of Maintenance of Locomotives.—The *Engineering News-Record* of New York gives some particulars of the relative cost of maintenance of electric and steam locomotives on the Norfolk and Western Railway. The average cost of repairs, power and lubricants for electric locomotive equipment, per 100 locomotive miles, was $62.9, while that of repairs, fuel, stores and lubricants for steam locomotive equipment was only $25.21. Repairs were respectively $33.69 and $12.7. Power and lubricants for the electric locomotives cost $30.21 per 100 locomotive-miles, as against $12.51 for fuel, stores, and lubricants for steam locomotives.

Chilian Saltpetre.—The trade in Chilian saltpetre in 1916 has beaten all previous records. The highest previous production—that of 1913—was exceeded last year by 120,000 tons, the total of saltpetre mined rising to 2,878,000 tons. Of this, 1,200,000 tons went to the United States of America, leaving more than 1,500,000 tons for Europe and other parts of the world. The methods of mining have been much improved of late.

American Wooden Ships.—According to the *Iron Age* of New York, the United States Government has given to the Foundation Company, New York City, a contract for building an indefinite number of wooden ships, which will be part of the fleet to be used in carrying food, munitions, and supplies to the Entente Allies. Work will be started immediately in building a plant near the city of New York; the plant will occupy 50 acres, with 1,500 ft. water-front. It will be under the supervision of the Government. The ships will be of 3,000 gross tons, and will cost about $350,000 each. The company is also investigating the possibility of establishing a plant on the Pacific coast for the building of vessels for the Government.

Gothenburg-Lake Venen Ship Canal.—Particulars of this canal, which has now been opened for traffic, are published in the *Engineering News* of New York. The canal is 52 miles long, of which 47 miles is provided by the canalisation of the Gota River. From the lake to the sea-level there is a fall of 145 ft., which is distributed among six locks. The canal is at present designed to carry vessels of 13·2 ft. draught, but it is intended eventually to be deepened to accommodate vessels of 16·4 ft. The minimum bottom width is about 80 ft.; the minimum width of the lock gates is 45 ft.; the length of the lock chambers is 296 ft., and the minimum depth over the sill of the locks is 18 ft. It is also proposed to begin the extension of a canal connecting the Baltic and Lake Maler. When this is completed the two largest lakes of Sweden will be accessible to sea-going vessels.

Hydro-electric Power in New Zealand.—The question of developing hydro-electric power in the North Island, New Zealand, is being investigated by Mr. Evan Parry, who has issued an interim report on the subject. The best source of power, he considers, is in the Arapuni Gorge, eight miles from Hira Hira, where it would be possible to obtain 120,000 h.p. on a 50 per cent. load-factor basis. He believes this scheme would be successful if only 40,000 h.p. were developed in the first instance: the cost of such a plant, with transmissions for serving surrounding districts, would amount to £1,200,000. The most suitable source of supply for Wellington is the Mangahao River, where 25,000 h.p. can be obtained on a 50 per cent. load-factor basis; and later on a further source of power might be obtained in the Taranaki district to supplement this.

Camphor Refining in Formosa.—With a view to exporting camphor in a finished state, it is proposed, says H.M. Commercial Attaché at Yokohama, to erect a camphor refinery in Formosa for the treatment of all the camphor of the island. A company with a capital of 1,000,000 yen is to be formed with this object. Hitherto the camphor produced in Formosa has been shipped abroad in its raw state, with the exception of a portion which was refined at Kobé.

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FRIDAY, JUNE 29, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. **(2)**

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The One Hundred and Sixty-third Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments during the past year, and also for the Election of Officers and New Fellows, was held in accordance with the By-laws on Wednesday last, June 27th, at 4 p.m., DUGALD CLERK, D.Sc., F.R.S., Chairman of the Council, in the chair.

The Secretary read the notice convening the meeting, and the Minutes of the last Annual Meeting.

The following candidates were proposed, balloted for, and duly elected Fellows of the Society:—

Clark, Frank William, M.I.Mech.E., 22, Montague-street, W.C. (1)

Dawson, Tom S., J.P., M.I.Mech.E., Victoria Jubilee Technical Institute, Byculla, Bombay, India.

Donald, James, Messrs. P. Orr and Sons, Limited, Post Box 198, Rangoon, Burma.

Drake, John William, The High School, Middlesbrough.

Gangaraju, Mothay, The Krishna Jute and Cotton Mills Company, Limited, Ellore, Madras, India.

Harper, John, Bengal Club, Calcutta, India.

Harter, Rupert William, Old Court, Malabar Hill, Bombay, India.

Hughes, John William, 50, Lime-street, E.C. (3)

Hurst, Lieut.-Colonel Godfrey Thomas, Elybank, 150, Essenwood-road, Berea, Durban, Natal, South Africa.

Jones, John Frederic, M.I.E.E., the Madras Electric Tramways, Limited, 1, Rundalls-road, Vepery, Madras, India.

Kapadia, Miss Bapai Pestonji, Kapadia House, Girgaum-road, opposite Wadia's Fire Temple, Bombay, India.

Kapadia, Hoemasji Pestonji, Kapadia House, Girgaum-road, opposite Wadia's Fire Temple, Bombay, India.

Kapadia, Pestonji Nadroji, Kapadia House, Girgaum-road, opposite Wadia's Fire Temple, Bombay, India.

Lee-Warner, William Hamilton, British Vice-Consulate, Batavia, Netherlands East Indies.

Mackenzie, Ian Scott, Madras Club, Madras, India.

Mathers, George Stanley Alexander, East Indian Railway House, Calcutta, India.

Mehd, Parjanyrai Vaikuntharai, M.A., B.Sc., Sadmata's-street, Ahmedabad, India.

Mitra, Hon. Rai Bahadur Mahendra Chandra, M.A., B.L., Hooghly, Bengal, India.

Morden, Christopher Roland, 5, Essex-court, Temple, E.C. (4)

O'Brien, Major Aubrey John, C.I.E., Hillside, Merstham, Surrey.

Richardson, J. W., Messrs. Steel Brothers and Company, Limited, Post Box 132, Rangoon, Burma.

Sheehy, Brian E. F., M.Inst.C.E. (Ireland), M.Inst. Water Eng., 57, O'Connell-street, Limerick, Ireland.

Sherrard, Captain G., Deputy-Director of Agriculture, care of D. S. and T., Baghdad, Mesopotamia.

Sparrow, Arthur J., A.R.I.B.A., 75, Lambeth Palace-road, S.E. (1)

Stitt, Gordon Holmes, Hong-Kong and Shanghai Banking Corporation, 9, Gracechurch-street, E.C. (3)

Thomas, Wyndham, Elsham Hall, Elsham, Lincs.

Verdier, Rev. Louis, 7, Churston Mansions, W.C. (1)

Watson, F. Mackman, Assoc.M.Inst.C.E., Selwood, Rotherham.

Williams, Gerald Walton, Pinner's Hall, E.C. (2)

Wilson, J. Howard, A.M., Ph.D., Castine, Maine, U.S.A.

Yung, M. H., Kwong Tung Yueh-Han Railway Company, Canton, China.

The Chairman appointed Mr. Byron Brenan, C.M.G., and Mr. Robert Anthony Gowan scrutineers, and declared the ballot open.

The SECRETARY then read the following—

REPORT OF COUNCIL.

The Council are glad to be able to report to the Fellows at the conclusion of the 163rd Session of the Society that, all things considered, they can congratulate the Society on a very successful and really prosperous year. The papers read both at the Ordinary Meetings and at the meetings of the Indian and Colonial Sections have been of an unusually high character, and will compare not unfavourably with those of any previous session. The number of Fellows, though there has been, as was inevitable, a certain falling-off annually since the commencement of the war, have yet been maintained in a manner which certainly was not anticipated when the war began. The Society's finances—in spite of losses on one hand, and increased expenses on the other, due to war conditions—are in a sound and fairly prosperous state. Its work, though conducted under conditions of extreme difficulty, has been well and successfully carried out. As regards the examinations—one of the most important departments of the Society — the inevitable drop in the number of candidates in the first two years of the war has now stopped, the numbers being, though very slightly, in excess of last year; and there is every reason to hope that they will increase in the next few years, so that the high numbers of pre-war years may again be reached. On the whole, though the Society, like every other institution in the country, has suffered from the war, it has suffered to a far less extent than was anticipated in the autumn of 1914.

I.—ORDINARY MEETINGS.

Of the papers which were read, or the addresses which were delivered, at the twenty Ordinary Meetings of the Society, only three dealt with subjects unconcerned with the war. The other seventeen were all more or less closely associated with it, and it is probably to this fact that the full attendance at our meetings was due. In the opening address with which, according to the usual custom, the Chairman of Council—Dr. Dugald Clerk—commenced the proceedings of the session, he continued to a large extent the treatment of the subject with which he dealt last session. In the address which he delivered in November, 1915, he compared the industrial and scientific methods of England and Germany, and ably defended those of our own country. Last November he carried out the same ideas to their legitimate development in their effect on "The Stability of Great Britain," and indicated some of the changes which, in his opinion, were necessary or desirable in order to attain continued security and prosperity. The address was no less appreciated, and no less popular, than the first one delivered by Dr. Dugald Clerk. It showed the same mastery of statistics and the same capacity for dealing in a wide and comprehensive manner with the difficult problems which Great Britain will have to face at the conclusion of the war.

The ideas put forward by the Chairman were developed or treated, though in divers manners and from different points of view, in several of the papers which followed. Prominent among these may be mentioned Mr. Wilson Fox's paper on "The Development of Imperial Resources." In it the author worked out the ideas which he had already put forward in two articles in the *Times* for the treatment of the resources of our vast Empire in such a fashion as to meet the enormous debt for which the Empire will certainly be liable at the end of the war, so as to relieve it from the great burden of taxation which otherwise we are certain to have to face. Another paper by Professor William Ripper, who succeeded our present Minister of Education in the office of Vice-Chancellor of the University of Sheffield, on "Works Organisation and Efficiency," dealt with the general question from yet another point of view, and indicated the manner in which our industries should be organised in order to meet at once the present difficulties in the provision of war supplies, and the future problems which will arise from their development to meet competition with those of other countries.

Yet another paper dealing, not indeed with the whole great subject, but with one important division of it, was that read by Mr. Leslie Urquhart on "The Economic Development of Russia and Britain's Interest therein." The conditions which existed when this able paper was read have indeed changed, but the facts enumerated and the principles laid down are none the less valuable whatever may be the ultimate outcome of the impending changes in that great country. Again, Mr. J. H. Vickery, in a paper on "German Methods"—the value of which was greatly enhanced by the author's long knowledge of, and familiarity with, that country—was a valuable contribution to the consideration of after-the-war problems.

Next may be considered a number of papers which dealt with individual industries or manu-

factures affected by the war. Of these one of the earliest was Mr. C. M. Whittaker's paper on "The British Coal-Tar Colour Industry," read in December. Of all our industries this is the one which is the most notorious as having been originated in this country, carried out to a certain extent, and finally developed in Germany in such a manner as to render the rest of the world solely dependent on that country for the supply of a most essential requisite in one of the greatest of all industries — the textile. Mr. Whittaker showed that during the two years in which the supply of German dyes had been absolutely cut off, a very large amount of work had actually been done in developing the manufacture in this country, so that the needs of the textile industry were, to a very large extent, already being supplied, with every probability that in the future the great colour industry would be re-established in the country of its birth.

Another scientific manufacture of high importance, though not comparable in extension to that of the coal-tar colours, but on which we were entirely dependent on Germany, was that of the supply of pharmaceutical products. This was dealt with in two excellent papers—one by Mr. Francis Hocking, who considered the scientific aspect of the question and the manufacture of the various synthetic products which have now to a very large extent replaced the drugs obtained from plants and from various mineral sources; the second was by Mr. J. C. Shenstone, who discussed the supply of herbs used for medicinal purposes. With less justification than in the case of the highly-developed products produced by German chemists, the supply of the old herbal remedies had to a very large extent been allowed to drift into foreign hands. An energetic effort is now being made to encourage the growth of medicinal herbs in England, and an interesting description of the whole case was given by Mr. Shenstone, who also strongly advocated the growth of plants having valuable medical qualities, but not suited for cultivation in our climate, in different parts of the British Empire. Along with these two papers should be mentioned one read by Dr. Fortescue Fox on "The Future of British Spas," since this dealt entirely with the question of British medicinal natural waters as compared with those of Germany and other countries. Dr. Fortescue Fox, while taking an unbiassed and perfectly impartial view of the comparative value of German and British waters, was able to make out an excellent case for the improvement of British watering-places, which, as he urged, depended not only upon the actual value of the waters themselves, but on the local organisations which, like their competitors abroad, ought to provide not only attractions for visitors, but also suitable arrangements for dealing with the patients.

Yet another chemical industry which has suffered through the war was that of Agricultural Fertilisers, and this subject was dealt with by Dr. J. Augustus Voelcker. In this case the difficulties arose not so much from the competition of other countries as from the fact that many of the necessary materials were not obtainable in this country, and their supply had consequently been cut off, either by difficulties of transport or by the fact that the supply came from hostile countries. Inasmuch as our supply of food depends to a very large extent now upon the amount of wheat which can be grown in this country, and as that again depends greatly upon the amount of fertilising material available, the importance of the question cannot be overrated, and Dr. Voelcker's paper was a very valuable contribution to the discussion upon it.

Another interesting contribution on the subject of Food Supplies was Sir Francis Fox's paper on "Flour and Bread." Sir Francis Fox is an ardent advocate of what used to be known before the war as wholemeal bread, and he laid great stress upon the advantages of the older methods of milling, in which practically the whole of the wheat, with the exception of the outer husk or bran, was ground into flour, as compared with the more modern methods of roller-milling which have been developed in order to produce whiter and more attractive looking bread. The paper was very fully discussed, advocates on both sides availing themselves of the opportunity to express their divergent views on the subject, and though Sir Francis Fox's opinions were by no means unanimously accepted, it was admitted by all that his contribution was one of considerable value, having regard to the present condition of our supplies of corn and our present difficulties in the production of bread.

Mr. Horace Thornton, who two years ago gave the Society a valuable paper on the uses of coal gas for industrial purposes, supplemented his former contribution by one showing especially to what a large extent coal gas was used as a fuel in the production of munitions.

The last paper which may be considered as included in this category was Dr. Dugald Clerk's

interesting history of the Internal-Combustion Engine. This did not, indeed, deal wholly with warlike matters, but it was to a large extent the application of the internal-combustion engine for war purposes, as in the motor and aeroplane, that led the author to present his paper to the Society.

Next come three papers dealing in various ways with the relief of sufferers from the war. The first of these was an account by Mr. W. A. M. Goode, Honorary Secretary of the National Committee for Relief in Belgium, of the work which had been done by the Committee in co-operation with the Neutral Commission, through whose agency most of it was carried out, for the relief of the suffering people in Belgium. The organisation, due to American influence, was most complete, the funds provided more than liberal, and the actual amount of relief afforded to the unhappy sufferers was incalculable. The way in which the whole difficult work was carried through was a masterly piece of organisation.

The second was an account by Miss Ella Sykes of her personal experiences in the work of the Y.M.C.A. in France. The value of this work, not only in France but in England, it is difficult to over-estimate, and the manner in which it has been carried out is admirable. The Young Men's Christian Association began by starting some huts where soldiers could obtain rest and refreshments on their way to the Front, and at the various training camps at home and abroad. In carrying out this work the Association secured the help of a number of devoted ladies, to whose individual labours perhaps hardly sufficient credit has been given. As the war has gone on the work of the Association has developed until upon it the soldiers both at home and abroad are to no small extent dependent for many comforts and small luxuries, which but for this organisation they would certainly have lacked.

The third paper was a spoken address, in which Sir Arthur Pearson gave an eloquent and interesting account of the magnificent work which he is carrying on for the help of blinded soldiers and sailors. Sir Arthur began with a brief but graphic account of the hostel in Regent's Park known as St. Dunstan's—certainly the finest establishment in existence for the benefit of the blind—and went on besides to give some most interesting information about the success which many blinded men, who have been taught at St. Dunstan's, have already attained in earning a livelihood. His audience also learned, though he did not tell them, how valuable must have been the effect of his own influence and example in encouraging those who have suffered the privation of the most valuable of all faculties to make a brave struggle against their grievous disqualification.

One other paper, not ostensibly associated with the war or its results, was the one read by Mrs. Hoster on the Training of Women for Employment; but, as a matter of fact, this paper probably would never have been read before the Society had not the need for women to take the place of men called away to the war drawn special attention to the subject. Mrs. Hoster gave an interesting account of the success which has already been achieved by the Institution with which she has long been associated in the training of women for special work of a secretarial and commercial nature, and in securing them permanent employment.

Finally come three papers, the subjects of which were entirely dissociated from the war and its concerns. The first of these was an interesting address by the Master of Magdalene College, Cambridge, Mr. A. C. Benson, on "Classical and Scientific Education." The subject is one which has been treated by many writers from many points of view, and it was interesting to hear the wise and liberal views of so accomplished a scholar, the better part of whose life has been devoted to educational matters, upon a problem the correct solution of which has not yet been discovered.

Mr. Lawrence Chubb's paper on "Highways and Byways" may be taken as a continuation of, or supplement to, the paper he read last year on the "Common Lands of London," and was of no less interest. It dealt with the second of the two objects of the valuable society of which Mr. Chubb has long been secretary, one of them being the preservation of commons, and the other the preservation of footpaths. The work which the society has done in the salvation of highways and byways all over the country is well known and fully appreciated, and the account of it, given by one who personally has done so much of that work, was extremely interesting.

Finally, there was a paper by Mr. George W. Jones on "Colour Printing." The subject is one which has been thoroughly dealt with by the Society in its various stages from its commencement years ago, in the suggestion of the three-colour method of colour printing and its elementary photographic applications, down to the present time. Mr. Jones dealt with its recent

developments, which are, indeed, due rather to skill and technical knowledge than to any very definite scientific advances. Some of the pictures shown as illustrations were certainly among the finest examples of modern printing in colours which have ever been exhibited.

II.—Indian Section.

Three out of the six papers read in this Section related to Indian industries—cotton, forests, and silk. A fourth was concerned with another economic subject—banking and thrift.

Cotton was in the competent hands of Professor J. A. Todd, who discussed the possibility of the present deficiency of the "bread and butter grades," amounting to a million bales a year, being supplied in the early future by enhanced production in India. Our only other available sources, it appears, are the African protectorates, and it is understood that they will not be able to meet the pressing demand for ten or fifteen years at the earliest. Professor Todd has great hopes of India, provided the necessary encouragement is forthcoming and a fresh policy adopted. At present the Government spends half a million annually on agriculture; Professor Todd was bold enough to ask for £10,000,000 a year for cotton alone. A Bombay Fellow of the Society, Mr. N. N. Wadia, speaking as a spinner and manufacturer, agreed that with Government help the outturn of long-staple cotton in India can be materially increased within a reasonable time. Another speaker, the Director of Agriculture in Madras, Mr. Chadwick, suggested that English spinners interested in Indian cotton should visit India and, after examining the conditions on the spot, give the Government the benefit of their advice.

A number of useful papers on the extensive State forests of India have been read before the Society since the formation of the Indian Section, fifty years ago, the contributors including the late Sir Richard Temple, Dr. (now Sir William) Schlich, and, more recently (1910), Sir Saint-Hill Eardley-Wilmot. The paper written in India by the Imperial Forest Economist, Mr. R. S. Pearson, and read by Mr. Laurence Mercer in April, differed from the earlier papers in being devoted entirely to development on the commercial side—preparation of paper pulp, manufacture of matches, antiseptic treatment of timber, etc. Mr. Pearson predicted that the bamboos and the elephant grasses which grow so abundantly in certain districts of India will eventually play a prominent part in the growing paper trade of India. The Chairman of the meeting, Sir Robert W. Carlyle, remarked that he could see nothing in India comparable to forests as a source of revenue.

At the request of the Indian authorities, Professor H. Maxwell-Lefroy went to India about a year ago for the purpose of inquiring into the silk industry of that country. The results of his extended investigations have been set forth in an exhaustive report now under official consideration and shortly to be available to the public. In the circumstances he was precluded, in the paper he read on his return to England, from discussing in detail the recommendations he has made to the Government of India, but he said sufficient to enable the trade to see what prospects there are of India sending us the larger supplies of raw products wanted by British manufacturers. In order to afford members of the Silk Association of Great Britain and Ireland, whose headquarters are in Manchester, an opportunity of hearing Professor Maxwell-Lefroy's paper, it was arranged to hold the annual meeting of that body in London on the previous day.

That the economic progress of India cannot be left to slow natural causes, but must be accelerated by well-conceived measures on the part of the State and of the people, was one of the propositions advanced by Mr. A. C. Chatterjee, I.C.S., in calling attention to the need for a larger development of banking and thrift. For some time after the war, India, it is expected, will be prevented by ruinous rates of interest from raising loans in London, and may not be able to borrow in the country itself anything approaching what she will require. He therefore wishes to see an active and sustained campaign of national thrift started as early as possible. The initiation of such a movement would be facilitated by the War Loan now under flotation, and he thinks that the organisations called into being for that object should be preserved as long as capital is needed for the country's material expansion.

In one of the excellent papers read by Colonel Sir Thomas Holdich before the Indian Section in past years he traced—in the light of knowledge not possessed by the Greek historians or, later, by any one previous to the surveys carried out by our Indian officers—Alexander's famous retreat from India. In the paper he read this session he attempted to elucidate another matter of itenrest to scholars and others—namely, the claim made by certain tribes on the Afghan side of the Indian frontier to be of Israelitish origin. Although mainly devoted to

an examination of the historical and geographical evidence in favour of that claim, the paper also referred to the question of the "open road to the East," and indicated what may be done by Russia or Germany, if not by ourselves, in the extension of Central Asian railways that may ultimately reach India.

The remaining paper, written by the present Director-General of the Indian Medical Service, Surgeon-General Sir C. Pardey Lukis, and read by Sir R. Havelock Charles, gave much information about recent important developments in medical research in India. The Secretary of State for India, Mr. Austen Chamberlain, presided, and in the course of an important speech mentioned that he was present partly for the purpose of pleading with the heads of the medical profession to help the Government to continue to get a superior class of recruits for the Indian Medical Service.

III.—Colonial Section.

One of the papers in this Section was read by a Belgian, Monsieur M. Horn (of the Ministère des Colonies de Belgique), and another by a Frenchman, Captain Philippe Millet, M.C. (Colonial Editor of *Le Temps* and late liaison officer on the Western Front). Both papers were in English.

The subject very ably dealt with by M. Horn was the Belgian Congo, and in requesting him to review the economic possibilities of a country as large as the British Isles, Belgium, France, Portugal, Spain, Germany, Switzerland, and Italy combined, the Committee had specially in view the general desire for more precise information as to the commodities which the Allied nations are or will be in a position to produce for their own and each other's requirements. Although the part which the Belgian Congo can take both as a source of supply and as a market may at present be comparatively small, M. Horn proved that it is of sufficient importance to be taken into account in the consideration of these great problems. The Under-Secretary of State for the Colonies, Mr. (now Sir) A. D. Steel-Maitland, M.P., who presided, expressed heartiest good wishes to Belgium in her task after the war—when she herself has been amply and fully rehabilitated—to make the most of her great possessions in Central Africa. Additional interest was afforded by the presence of M. Renkin, Colonial Minister of the Belgian Government, and H.E. Monsieur Paul Hymans, the Belgian Minister in London. The former took part in the discussion, and declared that the people of Belgium are even more determined than they were before the war to continue to hold the Congo and to work for its future development. Lord Leverhulme (formerly Sir William H. Lever), who travelled through the Belgian Congo with M. Horn, said that the latter had understated rather than overstated the facts as to the commercial prospects of the country and the civilising work that the Belgian Government are doing there.

Captain Millet's admirable and lucid paper was concerned with another part of the same continent—French North Africa—which, though not to be compared in size or potentiality with the great British dominions, is to France, he said, much more than a dominion. "It is a new France or, if you prefer, a prolongation of the French territory on the other side of the blue sea." What explains the prominent place of North Africa in the national life of modern France is not geographical situation or economic possibilities, but the presence from one end of the Atlas to the other of a mixed population which is a living reserve of energy. By the same process that every year enables the United States to turn thousands of immigrants into American citizens, France, in North Africa, is gradually absorbing large quantities of new European blood, mainly Spanish and Italian. With respect to inconveniences arising from the present diplomatic situation, there is not, he observed, one Frenchman who does not realise to-day that the maintenance of British power in Egypt is essential for the safety of France's North African Empire, the converse being equally true. France and England must in these matters support each other even more firmly than they have done in the past.

In the House of Commons on November 8th last, Mr. Alfred Bigland, the Member for Birkenhead, suggested a means of paying off the War Debt by increasing the productiveness of "Imperial estate." Speaking from forty years' experience of the West African palm-oil trade, he claimed that from that source alone a profit of £15,000,000 would be realised for Imperial needs by the adoption of the measures which he contemplated. His ideas on the subject were developed and elaborated in the paper, entitled "The Empire's Assets and how to use them," which he read before the Section on February 27th. He urged that the scheme of development and preference which he described might be adopted by the Allied Nations to their advantage and ours.

Another interesting paper of a somewhat

similar character was read by Mr. Octavius C. Beale, Representative and Past President of the Australian Associated Chambers of Manufacture, who has twice previously addressed the Society, and who on this occasion pleaded for Imperial and Allied Preference. He submitted that the burdens of the Allies after the war will be such as to "impel us to associate for the common relief."

IV.—Cantor Lectures.

There was only a single course of Cantor Lectures this session, the cost of the other lectures delivered before the Society being defrayed from the accumulation of the funds of the Howard and Aldred Trusts. This course was by Professor Beresford Pite, and the subject was "Town Planning and Civic Architecture." The course consisted of four lectures delivered in January and February last. The first three lectures were mainly historical—the first dealing with the ancient world and describing the method and art of city building in Egypt, Nineveh, Babylon, Athens, and Rome. The second dealt with Mediæval and Renaissance periods, the principal illustrations being taken from the four great cities of Italy—Florence, Venice, Milan, and Rome. Attention was also given to the architecture of the free cities of the Empire, and architectural examples from France, Germany, and England were included. The third lecture was devoted to the nineteenth century. The principal subjects were: Paris under the Empire; Vienna and Berlin; the American cities Washington, New York, and Chicago; with a final reference to Georgian and Victorian architecture in England. The concluding lecture was devoted to the Housing and Town Planning Act of 1909, and the future architecture of London and other English cities.

V.—Howard Lectures.

Two courses of lectures were given under the Howard Trust. The first of these was by Professor John S. S. Brame, the successor to Professor Vivian Lewes at the Royal Naval College, Greenwich. His subject was "Coal and its Economic Utilisation." The use and application of coal as a fuel both for manufacturing and domestic purposes, and as the source of the by-products from its distillation, were fully discussed, including specially the directions in which economy may be realised by the extended use of carbonised coal and of gas.

The second course of lectures under this Trust was on a somewhat kindred subject—"The National Shortage of Iron Ore Supplies"—and on this important subject Professor William Fearnsides gave two lectures in April and May. The first lecture was devoted to the home supplies of iron ore, and the second to overseas iron fields which supplied the British market. In addition to the hematitic belt which extended from Cleveland to Banbury, England possessed immense beds of low-grade ore. Germany's great output of pig-iron was due to the successful treatment of just such inferior ore, and if British metallurgists were to exploit our supply in a similar way, Professor Fearnsides thought there would be no national shortage of iron ore at all.

VI.—Aldred Lecture.

Three lectures were given under this Trust by Mr. Lawrence Weaver on "Memorials and Monuments." The whole question of memorial design in all its various forms from mural tablets to large regimental and civic monuments was fully dealt with. The subject had naturally been brought to the front by the war, and full attention was given to the special subject of war memorials.

VII.—Juvenile Lectures.

Last year when the question of continuing the Juvenile Lectures during the war was considered by the Council, the matter was settled by the kind help of two members of the Council, Professor J. M. Thomson and Mr. James Swinburne, who each volunteered to deliver one of the two lectures.

This year the Council have again to express their appreciation of the generous assistance of one of their own members, Mr. Alan Campbell Swinton, who kindly gave the Society two admirable lectures on "Electricity and its Applications." In two hours Mr. Campbell Swinton took his youthful audience through the whole history of electricity, from the earliest recorded observations of Thales of Miletus (*circa* 600 B.C.) down to the latest developments of the telephone, wireless telegraphy and the electric light. Needless to say, there was not much time for the description of details or the discussion of principles, so the lecturer contented himself with the selection of a number of fine typical experiments, all of a brilliant and attractive character, just linked together by a condensed narrative, but all clearly and lucidly explained. This series of experiments illustrated the whole science, and included the decomposition of water, the origin of the dynamo, the duration

of the electric spark and its application to the photography of a flying bullet, high-frequency induction phenomena, the mercury arc lamp, the little-known effect of heat in rendering glass conductive, and very much more. It should be added that Mr. Campbell Swinton not only took on himself the trouble of preparing the lectures and collecting the large amount of apparatus required, but also insisted in defraying all the cost of the lectures.

VIII.—Albert Medal.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of the President, H.R.H. The Duke of Connaught and Strathearn, K.G., to Orville Wright, "In recognition of the value of the contributions of Wilbur and Orville Wright to the solution of the problem of mechanical flight." In considering the value of the work of the two brothers it is impossible to allot to either the more important share, or to separate the work of one from the work of the other. They laboured together in sympathetic union, and it is possible that neither could have succeeded without the help of the other. As Wilbur Wright, who was born in 1867, died in 1912, the Council are only able to make the award to the survivor as a testimony of appreciation of the joint labours of his brother and himself.

To discriminate between the claims of inventors is always a task of difficulty, and to allot to any individual the credit of having invented and made the first flying machine would be impossible. The solution of the problem of flight has been attempted in many ways, and has occupied the attention of many minds. For years the production of some "heavier than air" machine which should, by mechanical means, overcome the force of gravity has been the object of numerous experiments, though for long the results achieved attracted rather derision than serious attention.

In 1896 the Wrights began to experiment with gliding machines, continuing the work of Lilienthal and Pilcher, which had been cut short by their deaths. Having obtained considerable success with "gliders"—for Orville Wright on one occasion succeeded in making a soaring flight of ten minutes—in 1903 they fitted an engine and propeller to their machine, and with this apparatus they were able to make short flights. Inasmuch as this was the first apparatus in which a man was carried in the air by mechanical power, though Langley and others had previously made small mechanical flying machines, it may fairly be considered the first aeroplane in the present acceptation of the word.

The machine was patented in 1907. The validity of the patent has never been confirmed by any legal decision, but practically the British Government admitted its validity by a payment to the inventors in 1914 of £15,000. After the initial difficulties had been overcome by the patient labours of the Wrights, the machine developed rapidly. It may be true that in the present aeroplane not much is left of the machine described in the 1907 patent, but the changes, apart from the improvements in the engine on which the modern aeroplane mainly depends for its success, have all been legitimate developments of the ideas of the original inventors, and in no way detract from their credit. It remains, therefore, certain that, whatever value may attach to the contributions of others, the largest share in the honour of having invented the aeroplane must always be given to the two brothers Wilbur and Orville Wright.

IX.—Medals for Papers.

The Council decided that the number of medals for the papers read before the Society during the present session should be limited to six in all—four for papers read at the Ordinary Meetings and one each for the Indian and the Colonial Sections.

The following awards have been made:—

At the Ordinary Meetings:—

A. C. Benson, C.V.O., Master of Magdalene College, Cambridge, "Classical and Scientific Education."

Francis A. Hocking, B.Sc., Pharmaceutist to the London Hospital, "The War and Our Supply of Drugs."

Sir C. Arthur Pearson, Bt., Chairman, Blinded Soldiers and Sailors Care Committee, "The Blind Sufferers from the War and their Future Employment."

Leslie Urquhart, "The Economic Development of Russia and Britain's Interest therein."

In the Indian Section:—

John Aiton Todd, D.L., Professor of Economics, University College, Nottingham, "The World's Cotton Supply and India's Share in it."

In the Colonial Section:—

Captain Philippe Millet, Colonial Editor of *Le Temps*, "The Problems of French North Africa."

It has for long been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society, or

were members of the Council. Acting on this rule the Council were precluded from considering the following papers:—

At the Ordinary Meetings:—

DUGALD CLERK, F.R.S., "The Internal-Combustion Engine."

MISS ELLA C. SYKES, "The Work of the Y.M.C.A. in France."

HORACE M. THORNTON, "The Application of Coal Gas to Industry in War Time: its National Importance."

J. AUGUSTUS VOELCKER, M.A., Ph.D., F.I.C., "Fertilisers and their Supply in War Time."

In the Indian Section:—

COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., "Between the Tigris and the Indus: The Ben-i-Israel."

The Council, however, desire to express their high appreciation of these papers.

X.—OWEN JONES PRIZES.

After the death, in 1874, of Owen Jones, a committee was formed to collect subscriptions for the purpose of founding a memorial, and the balance (a sum of £400) was presented to the Council of the Society of Arts upon condition of their expending the interest thereof in prizes to "Students of the Schools of Art who, in actual competition, produce the best designs for Household Furniture, Carpets, Wallpapers and Hangings, Damask, Chintzes, etc., regulated by the principles laid down by Owen Jones." The prizes were awarded annually from 1878 to 1915 on the results of the annual competition of the Science and Art Department, and its successor, the Board of Education. The awards were always made on the recommendation of the examiners for the "National Competition."

Six prizes were offered for competition each year, each prize consisting of a bound copy of "The Leading Principles in Composition of Ornament of Every Period," from the "Grammar of Ornament," by Owen Jones, and the Society's Bronze Medal.

In 1916 the Board of Education decided to suspend the "National Competition," and so it was no longer available as a basis for the award of the prizes. The prizes under the terms of the Trust are only open to "Students of the Schools of Art," and though the Board expressed their readiness to assist the Society it appeared that there was no convenient arrangement under which the proper adjudication could be carried out, and the offer of the prizes had to be dropped for the year.

This year the Council determined to offer the prizes direct to the Schools of Art, and to appoint their own judges to make the awards. All the difficulties of arranging for the reception and examination of the competing designs were removed by the kind co-operation of the Director of the Victoria and Albert Museum, who consented to provide the necessary accommodation at the Museum, and to offer all facilities for their proper inspection and the adjudication of the prizes.

Notice was accordingly issued in November last to the principals of Schools of Art that the usual prizes would be offered for "Designs for Textiles" under certain specified categories,* and that designs in competition might be sent to the Victoria and Albert Museum between the 25th and 30th of the present month. The Council have secured the help of several highly qualified gentlemen who will advise them as to the awards, and as soon as their reports have been received the awards will be published.

It remains to be seen whether an independent competition will attract as many candidates as entered under the old conditions, but the Council hope that the work sent in may be of as good a character. As was stated in last year's report, they realise that the Owen Jones prizes have been greatly appreciated by the numerous students who have received them, and that they have served as a useful stimulant to the study of decorative design.

XI.—NORTH LONDON EXHIBITION TRUST.

In 1865 the Committee of the North London Working Classes and Industrial Exhibition (1864) presented to the Society of Arts a sum of £157, the balance of the surplus from that exhibition, with a view to the award annually of prizes for the best specimens of skilled workmanship exhibited at the Art Workmanship Competitions of the Society.

The Art Workmanship Competitions were discontinued after 1870, and it then became rather difficult to know how the funds arising from the Trust could be disposed of in a manner which might accord with the intention of the donors. In 1884 the Society awarded certain prizes in connection with the Inventions Exhibition, and among these was one (a gold medal or £20) offered under the Trust in question for the best set of specimens illustrating the handicraft teaching in any school. In 1896 an amount of £22 odd was awarded in prizes at the East London Exhibition held in that year.

* For details of the competition see *Journal*, December 8th, 1916.

There was in 1902 a small accumulation of the interest on the invested capital, and the Council decided that a very proper way of disposing of the available amount would be to offer it in art workmanship prizes for students connected with that part of the metropolis where the North London Exhibition was held. They, therefore, offered prizes for Art Workmanship amounting to fourteen guineas to students in the Art classes of the Northampton Institute, Clerkenwell.

The prizes were duly awarded in November, 1903, and as the result of the competition appeared satisfactory, the offer was renewed for the following year, and was continued annually till 1916. The amount varied in different years, but was eventually fixed at £5 for each year.

XII.—Examinations.

The examinations have been held this year, as in the two previous years, in two divisions, the first division from Monday, March 26th, to Monday, April 2nd, and the second from Monday, May 14th, to Wednesday, May 23rd. The longer period was required for the second division because all the subjects for which the entries are usually not very numerous were postponed to it, as it was not thought necessary to provide more than a single examination in those subjects.

The total number of entries received was 26,185 — 10,411 for the March division, and 15,774 for that of May. This included applications from 279 prisoners of war or interned men at Ruhleben, Groningen, Chateau d'Oex, and Mürren. From London, where the examinations are supervised by the Education Committee of the London County Council, nearly 5,000 entries were received. The remaining 21,000 came from 375 centres throughout the United Kingdom.

The total number of entries for the examinations in 1916 was 25,991, of whom 87 were interned men or prisoners of war examined at Ruhleben and Groningen. It will thus be seen that there is a slight increase in the total number of entries for the current year, though the numbers are still very far behind those of the years before the war. In 1914 there were 37,974, and this was the highest number ever reached. The number of papers actually worked was 35,422. It should be noted that the number of original entries is always in excess of the numbers coming up for examination. The difference varies; it has of late years sometimes reached 8 per cent.

There was a heavy reduction in 1915 due to the war, and the diminution continued last year, so it is extremely satisfactory to know that the falling-off has now, at all events for the present, come to an end. It is also satisfactory that this slight increase has accrued in spite of the additional amounts which were added to the entrance fees, viz. 6*d.* per entry in the two lower stages, and 1*s.* in the advanced. The financial result is also good, as the total received in fees for the present year is £3,430, an excess of £700 over the corresponding figures for 1916.

The Financial Statement for the current year shows a small balance of £220 on the right side in the examination charges, whereas there was a deficit of £1,035 in 1915–16, and one of £875 in 1914–15. As has been before stated, the date of the Statement (May 31st) causes the annual examination accounts to be somewhat misleading. A correct view of each year's costs and receipts can only be obtained by averaging a series of years, since the costs come into the accounts of one year and the receipts into those of another year. But, however the matter is looked at, it is certain that the present year's examinations have produced a small margin of receipts over expenditure.

The subjects as usual included the chief elements of a commercial education—Book-keeping, Typewriting, Shorthand, Arithmetic, Economics, Commercial Law, Commercial Geography, etc., and Modern Languages. The commercial subjects as usual attracted the great majority of the candidates, there being, for instance, 7,254 candidates in Book-keeping. The numbers in Modern Languages were not so large. French is the only modern language for which the entries are really high. This year there are altogether 2,156 entries, and this shows a falling-off on last year, when 2,285 candidates actually came up for examination. Examinations in Russian have been held for many years, but only with an insignificant number of candidates until last year, when there were 127. In the present year the numbers have more than doubled, as they have now reached 314. This is the largest number of entries for any modern language subject, except French. German, for which a considerable number (about 800) used to enter, dropped to 270 last year, and the entries this year are only 256. Spanish has increased from 149 to 270, and Italian from 61 to 83. Taking all the modern languages (exclusive of English) together there are this year 187 more entries than there were papers

worked last year. This probably means that the numbers of actual candidates this year will be very much the same as in 1916. As regards the examination in English for foreigners, which was started last year and attracted 547 candidates, only 248 entries were received. No examinations were held in Danish and Norwegian, Swedish, Dutch, Hindustani, Chinese, Arabic, or Japanese, there being very few entries for any of these subjects. For many years the Society has endeavoured to encourage the study of these languages, but so far it must be admitted without much success. The numbers also entering for Portuguese were so few that no examination was held in this subject. This is the first year in which it has been omitted.

The results of the First Division of the examinations, held in March, have already been made known to the candidates, and those of the May Division will be announced as soon as possible.

XIII.—Viva Voce Examinations in Modern Languages.

Up to the present date eight examinations in French have been held this year in London and Manchester.

At these examinations 190 candidates presented themselves, of whom 143 passed (56 with distinction) and 47 failed.

Other examinations have been arranged in French, and also in German, Spanish, English for Foreign Students, and Russian.

XIV.—Conjoint Board of Scientific Societies.

It was stated in the last Report of the Council that the Royal Society has formed a conjoint Board of Scientific Societies, consisting of representatives of twenty-six societies, of whom the Royal Society of Arts was one.

In the year which has since elapsed, the Board has been regularly organised, and the number of the constituent societies has been increased, an executive committee has been appointed, and numerous meetings both of this committee and of the Board itself have been held. Various committees for special purposes have been nominated and are now at work.

The delegates appointed in the first instance to represent the Society were Sir Philip Magnus and Sir Henry Trueman Wood, who still continue in office.

A contribution of £20 was made by the Council to the funds of the Board.

XV.—The Journal.

The restrictions on the supply of paper at one time threatened to render inevitable the abandonment, or at all events the suspension, of the publication of the *Journal*.

Arrangements were, however, made for the provision of a limited supply, though the shortage of supplies and their greatly increased cost have rendered it absolutely necessary to reduce the size of the *Journal* to the smallest practicable amount. Since March, 1915, therefore, it has appeared as a single "sheet" of sixteen pages, these limitations having only been exceeded when it was impossible, without exceeding them, to continue the regular publication of the Society's Proceedings.

So far as was possible, the reports of the discussions, especially those of the regular Wednesday meetings, have been abridged, and efforts were also made to keep the papers themselves within shorter limits than usual, though it may be admitted that this very difficult part of an editor's duties was not always successfully performed.

On the whole, however, it is believed that the Fellows generally appreciate the difficulties under which all periodical publications are produced, and accept the *Journal* in its somewhat meagre and shrunken form as not inadequate or wholly unsatisfactory.

XVI.—List of Fellows.

The number of life and subscribing Fellows on the Society's books is now just under 3,550. This includes a few Institutions in Union who subscribe from their own funds.

During the last fifty years the number of the Society's Fellows has not varied within very wide limits. In 1870 there were a little over 3,200; this rose in 1875 to 3,800. The numbers fell to 3,300 in 1881, and rose again to 3,656 in 1885. By 1899 the numbers had fallen to 3,078, rising again in 1900 to 3,123. Then there was a continuous increase up to 3,722 in 1915. In 1916 there was a falling-off of 125, and in the present year the numbers have been reduced by 58, as there were 218 deaths and resignations, and 160 new Fellows.

In 1850 the numbers were a little under 2,000. The increase in the twenty years succeeding 1850 was doubtless due principally to the great Exhibitions of 1851 and 1862.*

* Some further information about the number of members before 1850 was given in the Report of 1914. See *Journal*, Vol. LXII. p. 692.

XVII.—Medal Designs.

The Executive Committee of the Exhibition of Medallic Art lately held in London applied to the Council for the co-operation of the Society, and the Council placed three of the Society's Silver Medals at the disposal of the Committee for awards for Medal Designs. These have been awarded for the best Portrait, the best Allegorical or Symbolical Design, and the best Historical Design. The names of the recipients will be found in the *Journal* of the 15th inst. (page 529).

The encouragement of the art of Die-sinking has always been a matter of interest to the Society. In 1758—four years after the foundation of the Society—prizes were offered for designs for medals, and a number of awards were made for medals designed to commemorate British victories from the date above mentioned down to 1772.

XVIII.—Soane Museum.

Under the Act by which the affairs of the Soane Museum are regulated, the Royal Society of Arts have to nominate one of the trustees. The office is held for five years, and the last election having been in 1912, it is necessary that the Society should exercise its power during the present year. The Council recommend for election Mr. Alan S. Cole, C.B., who was Trustee for the period 1876–1882.

In 1833 Sir John Soane presented to the nation the house which he had built in Lincoln's Inn Fields, and in which he had placed his very valuable collection of pictures and objects of antiquarian interest, together with his extensive library. At the same time he obtained an Act of Parliament by which the property was vested in trustees—four appointed by himself, and five by the Corporation of London, the Royal Academy, the Royal Society, the Society of Antiquaries, and the Society of Arts—the four original nominated trustees having the power to fill up by election vacancies in their number as they occurred. Sir John Soane also provided the funds necessary for the maintenance of the house as a Museum. He died on January 20th, 1837.

The following is a list of the trustees appointed by the Society:—

1837 to 1843—H.R.H. the Duke of Sussex, President of the Society.

1844 to 1857—H.R.H. the Prince Consort, President of the Society.

1857 to 1864—Sir Charles Wentworth Dilke, Bt.

1865 to 1876—Samuel Redgrave.

1876 to 1882—Alan S. Cole, C.B.

1882 to 1896—Sir Benjamin Ward Richardson, M.D., F.R.S.

1897 to 1917—Sir George Birdwood, K.C.I.E., C.S.I., M.D., LL.D.

XIX.—New Council.

The Vice-Presidents retiring under the ordinary regulations are Sir George Birdwood, Lord Inchcape, Mr. Edwin L. Lutyens, Mr. Ernest Pooley, and Professor J. M. Thomson. In their place the Council recommend for election Mr. P. M. Evans and Sir Boverton Redwood, Bt., who retire from the Council this year, and also Lord Islington, G.C.M.G., Major-General Sir Desmond O'Callaghan, K.C.V.O., and the Hon. Sir Charles Parsons, K.C.B., F.R.S., none of whom have served previously as Vice-Presidents. H.R.H. the President has also intimated his intention of nominating for election as a Vice-President Field-Marshal Sir Douglas Haig, G.C.B., G.C.V.O., who has been a member of the Society since 1895.

The retiring Members of Council are Sir George Beilby, Mr. P. M. Evans, Colonel Sir Henry Capel Holden, Major Francis Grant Ogilvie, Sir Boverton Redwood, and Mr. John Slater. To fill the vacancies the Council nominate Major E. H. M. Leggett, D.S.O., Dr. William H. Maw, Sir Francis T. Piggott, Professor Arthur Schuster, F.R.S., Dr. J. A. Voelcker, and Mr. Frank Warner. Of these only Dr. Maw has previously held office.

XX.—Obituary.

The Duke of Norfolk, who died in February last, became a Fellow of the Society in 1914; he was at once elected a Vice-President, and continued to hold office until his death. The Earl of Cromer joined the Society in 1903, and served as a Vice-President from 1908 to 1912. In 1908 he received the Society's Albert Medal.

Mr. George Drummond, the owner of the Adelphi Estate, had been the landlord of the Society since 1867, when the Society's original lease from the Brothers Adam expired. He became a member of the Society in the following year, 1868. Sir Hiram Maxim described the gun with which his name will always be associated at a meeting of the Society in 1885. In 1894 he read a paper on his flying machine, and in 1908, speaking in a discussion here, he gave a very full account of the conditions which aeronautics had attained at that time.

Mr. Reginald Le Neve Foster, a son of the last Secretary of the Society, founded the Peter

Le Neve Foster Prize in memory of his father. It was awarded for the first time last year. Mr. H. B. Wheatley was nominated a life Fellow of the Society in 1908 on his resignation of the post of Assistant Secretary, which he had held since 1879.

Sir Arthur Lasenby Liberty, who had been a Fellow since 1883, read several interesting papers on subjects connected with the industrial application of Art before the Society. Sir Marc Armand Ruffer, who died in May on his way back to Cairo from Salonica, read in 1889 a paper on Rabies, and was elected a member in the following year. Before his death he had achieved a high reputation as a bacteriologist and sanitarian.

Mr. Walter Hancock was a very old member of the Society, as he was elected in 1859. His father was well known for the important share he took in the first practical application of gutta-percha. Mr. Hancock was associated with his father in much of his work, which he carried on after his father's death.

Sir Walter Vaughan Morgan became Lord Mayor of London in 1905, at the age of seventy-four. Mr. Frank Debenham was well-known for his interest in municipal affairs and in education.

Lord Allerton was for many years Chairman of the Great Northern Railway.

Among other notable Fellows of the Society who have passed away during the year may be mentioned—Sir Howard Elphinstone, Mr. Leopold de Rothschild, Sir Richard Burbidge, Sir Cavendish Boyle, Sir Joseph Beecham, Sir Robert Mowbray, and Sir John Muir-Mackenzie.

XXI.—Finance.

The annual statement of receipts and expenditure was published—in accordance with the usual practice—in the *Journal* last week. It shows the revenue and expenditure for the financial year ending May 31st last, the assets and liabilities of the Society, its investments and the trusts standing in its name.

For the last two years the Society's Annual Statement has shown a deficiency as the result of the year's working, amounting in 1916 to £1,183 and in 1915 to £1,079. In the last-named year the deficiency was met by the paying off of £1,400 Queensland Four per Cent. Bonds held by the Society, which matured in that year. This money was not reinvested, but was applied to make up the deficiency in current account.

Practically this deficit was due to losses on the Society's examinations, amounting to £1,035 in 1916 and £875 in 1915. To meet this annual loss the examination fees were raised, and the result, as stated in another part of the report, was that there was a small balance to the good of £220 in the examination accounts.

The consequent result on the whole working of the Society for the past financial year is that the deficiency on the year's work has been reduced to £82; so practically it may be said that the Society's accounts will balance for the financial year just concluded.

The total subscriptions for the year show a slight increase amounting to £25, which under present conditions may be regarded as highly satisfactory.

There is perhaps nothing else to which special attention need be drawn, except that it may be stated that, if there is no decrease in the total of the Society's outgoings, it has only been by the strict exercise of economy that the Society's income has been made to suffice for the great increase in all prices and charges which have to be met.

When in January the last War Loan was raised it appeared to the Council that the Society, if possible, ought to apply for a moderate allotment in the loan. So the Council took advantage of the fact that £3,000 which the Society holds in Newcastle-upon-Tyne 3½ per Cent. Stock would mature in 1920, and therefore stood at a much higher rate than most of the Society's other securities. This enabled them to borrow on the security of this Stock a sum of £1,900 from the Society's bankers, and this they invested in the purchase of £2,000 War Loan.

So far the only call on the Society's accumulated funds since the beginning of the war has been the application above mentioned of the £1,400 realised by the paying off of the Queensland Bonds in 1915.

The Chairman (Dr. Dugald Clerk, F.R.S.) moved the adoption of the report, and congratulated the Society upon its excellent character. The finances of the Society, owing to the improvement in the examination receipts, were in a more satisfactory condition than the Council had anticipated. The Council felt that the Society was not justified in continuing to incur a deficit on the examinations, and that the fees charged, which were exceedingly low, could well bear the small addition which had been made to them this year. He thought the papers and lectures had been even better than in previous years, and congratulated the Society on the result of the year's work.

Lord Sanderson, G.C.B., K.C.M.G., had great pleasure in seconding the adoption of the report. He said he could well recommend it to the Fellows, and that his only regret was that he had not been able to be present at almost all the papers so well described in it.

Sir Philip Magnus, Bt., M.P., considered the report most interesting. It reflected very great credit upon the officers of the Society for the care they had taken and for the successful way in which the Society's affairs had been managed. Like Lord Sanderson, he wished he could have been present at the reading of many of the papers summarised in the report. It showed, he thought, what the reports of many other societies had failed to show at the present time—namely, that the Society had been able, during the war, to do almost as much good as it has done in preceding years. There had been no falling-off in any branch of the Society's work. Other examining bodies had also found that the cost of their examinations had exceeded the amount of fees received, and he was glad to see that this was not now the case with the Royal Society of Arts. The Society had also undertaken other important work during the year, and he thought it must be gratifying to the Fellows as well as to the Council that the work had been so successfully carried out.

The adoption of the report was then agreed to.

The Chairman said it was now his great pleasure to rise to propose a cordial vote of thanks to Sir Henry Trueman Wood, and the other officers of the Society, for their services. The Council, he said, all tried to do their duty, but really the heavy work of the conduct of the affairs of the Society fell naturally upon the Secretary and his staff. All the officers of the Society had responded nobly to the call, notwithstanding the reduced staff, and the work had been carried on most efficiently. He had very great pleasure in proposing the vote of thanks, but this pleasure was very much alloyed by the fact that he had to announce that Sir Henry Wood had found it necessary to resign his post as Secretary of the Society. They all felt that it was a great misfortune; but they could well understand Sir Henry at his age—although it was not so very great—wishing to enjoy a little rest. They all realised the value of the work Sir Henry had done during his long term of office, and they knew how the prosperity of an institution depended on its having a capable and efficient secretary. He had for many years exercised a judicious domination over the Society, and its present prosperous condition was due to the wise and sensible manner in which he had always managed its affairs. The Council, he said, had tried to get Sir Henry to alter his decision, but he had definitely made up his mind to resign the Secretaryship as from September next, and the Council had accepted it with very great regret. Mr. G. K. Menzies who, as the Fellows knew, had been Assistant-Secretary since 1908, had been training up for the duties, and was thoroughly conversant with the work of the Society. The Council, therefore, had had great pleasure in appointing him as Secretary to succeed Sir Henry Wood, and he felt sure Mr. Menzies would carry out all the duties in a thoroughly efficient manner.

Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., said he had the greatest possible pleasure in seconding the vote of thanks to the Secretary and other officers of the Society, although his pleasure in doing so was very sadly diminished by the thought that this was the last occasion on which they would have the opportunity of thanking Sir Henry Wood for his work as Secretary of the Society. Forty-five years was a long time, but he wished they had been able to prevail upon Sir Henry to stay on for another five years, and so complete half a century's service, with all possible advantage to the Society. To quote the old Latin adage, *Pereant illi qui ante nos nostra dixerunt*: the Chairman had left him hardly anything to say. He had always felt that there should be an understudy to take the Secretary's place, and was glad when Mr. Menzies' appointment was made. He thought great credit was due to the Secretary, the Assistant Secretary, and to Mr. S. Digby, Secretary of the Indian and Colonial Sections, for the brilliant quality of the papers during the past session, and had much pleasure in seconding the vote of thanks.

The Secretary said the Fellows could well understand with what feelings of regret he rose to reply to the vote of thanks they had so kindly accorded him. He had hoped he might have been able to carry on the work of Secretary until the end of the war, but for personal reasons—with which he would not trouble them—he felt that the time had really come when it would be wise for him to retire before being compelled to do so by failing health or failing energies. The Council, he said, had been most kind to him, and he appreciated very much the way in which they had accepted his resignation and had treated him. They desired that he should become a Member of the Council, and they also proposed to pay him the very high compliment of instituting an annual lecture which would bear his name, and would be given on some subject closely connected with the work of the Society. He said he was glad to be able to leave the Society in a better position financially than it was when he first became connected with it. At that date it had no accumulated funds, and was content to live from hand to mouth on its annual income. It now possessed a reserve of some £20,000, which in times like the present was a valuable safeguard, and would enable it to tide over many lean years. Although the Society was doing valuable work then—quite as valuable perhaps as it was doing at the present time—still there was no possible doubt that the reputation of the

Society stood very much higher now than it did in those days. The only thing in which there had been no improvement was in the number of members, and this really was not to be wondered at, considering the enormous growth of kindred societies, and the ever-increasing claims upon those who subscribed to societies like our own. Although the number of Fellows had not increased, the list had been extended to all parts of the world—quite a third of the Fellows were resident in, or connected with, India, the Colonies, and America—so that the Royal Society of Arts might now claim to be regarded as an Imperial Society. For these results he did not claim the credit. What he did claim was that he had always laboured hard to induce distinguished men to associate themselves with the work of the Society, as the tablet recording the names of Chairmen of Council and the old lists of Council would show. The Society had been fortunate in securing the help of many men of high distinction and well known in Science, Art, Literature, and Commerce; and it was mainly to their efforts that the growth and the success of the Society were due. He was glad Mr. Menzies had been appointed to succeed him. He had, he said, always felt that the executive head of any institution ought to have an understudy, and he had looked upon Mr. Menzies as his understudy, and had trained him for the work, and he felt that Mr. Menzies was perfectly capable of carrying on the work of the Society. He had held the office of Secretary longer than anyone else since the Society was first formed, over one-hundred-and-sixty years ago; but he was not the senior member of the staff, for the present Chief Clerk, Mr. George Davenport, was here a few months before he came. With that one exception the whole staff had been changed. Davenport was not more than a lad when he was first engaged to assist his uncle, who was long the financial officer of the Society. He rapidly picked up a knowledge of scientific matters, and had now become one of the most expert lantern operators in London. All who had read papers or lectured before the Society would know how much they were indebted to him for his assistance and ingenuity in devising experimental and other illustration. He also wished to refer to the valuable work carried on by Mr. J. H. Buchanan (the Accountant) and Mr. C. D. Cassidy (the librarian) in connection with the examinations. Owing to the fact that two of the examination staff had been called up for military service, they had been very short-handed; but they had managed to carry out all the complicated details of the work without any other help at all. What would be the number of the staff required to carry out such work in a Government office he hardly liked to think. He wished also to record his personal indebtedness to the loyal and ungrudging help he had received for nearly twenty-five years from Mr. H. J. Dack, who had acted during that period as his own shorthand writer. Finally he desired to acknowledge the efficient way in which Mr. S. Digby had carried on the work of the Indian and Colonial Sections. He took an enormous amount of trouble in obtaining suitable papers for this important branch of the Society's work, and thereby greatly extended the influence of the Society in India and the Colonies. He said he should like to take this last opportunity of thanking all those who had worked with him, and hoped that they would continue to carry on the work as successfully as ever. The Society had done most valuable work in the past, and there was still an abundance of useful work to be done in the future. He thought it might with great advantage take up the question of Industrial Research. This was a most important matter, and there would be many opportunities for dealing with it when the war had come to an end. He spoke of the happy relations which had always existed between all the Councils he had served under and himself, and concluded by reading the following letter from Sir Malcolm Murray, Comptroller to His Royal Highness the President of the Society:—

Clarence House,
St. James's, S.W.,
June 23rd, 1917.

DEAR SIR HENRY WOOD,

I have submitted your letter of the 21st inst. to H.R.H. the Duke of Connaught, and am desired by His Royal Highness to say how sorry he is to hear that you are resigning the Secretaryship of the Royal Society of Arts next September, after your long connection with it. Sorry as he is himself to lose your services, and sorry as he is sure the Council will be, he feels that you have well earned a rest from your duties.

He would wish to express to you his sincere thanks for the assistance you have always given.

Believe me,
Yours sincerely,
(Signed) MALCOLM MURRAY.

THE CHAIRMAN said he was glad Sir Henry Wood had referred to the proposed lecture which the Council desired to institute in order to keep up his connection with the Society. There would be an annual lecture called "The Trueman Wood Lecture," which would be delivered by a man of distinction, and would deal with the Application of Science to Industry. He was also glad to say that they would still have Sir Henry Wood's help and his great experience, although he would no longer be their Secretary. He was sure the Fellows were delighted to hear what Sir Henry had said about the Society, although they were all very, very sorry to part with him.

The ballot having remained open for half an hour and the scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. [The names in

italics are those of members who have not, during the past year, filled the office to which they have been elected.]

PRESIDENT.

H.R.H. The Duke of Connaught and Strathearn, K.G.

VICE-PRESIDENTS.

Sir George Ranken Askwith, K.C.B., K.C., D.C.L.
Arthur James Balfour, O.M., P.C., LL.D., D.C.L., M.P., F.R.S.
Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.
Lord Blyth.
Sir (Frederick) William Duke, K.C.S.I., K.C.I.E.
Peter MacIntyre Evans, M.A.
Lord Faringdon.
Field-Marshal Sir Douglas Haig, G.C.B., G.C.V.O., K.C.I.E.
Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
Lord Islington, P.C., G.C.M.G., D.S.O.
Major Percy A. MacMahon, R.A., LL.D., Sc.D., F.R.S.
Sir Philip Magnus, Bt., M.P.
Lord Moulton, P.C., K.C.B., M.A., LL.D., F.R.S.
Lord Newlands, LL.D.
Lord Northcliffe.
Major-General Sir Desmond D. T. O'Callaghan, R.A., K.C.V.O.
Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.
Hon. Richard Clere Parsons, M.A.
Sir Boverton Redwood, Bt., D.Sc., F.R.S.E.
Lord Sanderson, G.C.B., K.C.M.G.
Alan A. Campbell Swinton, F.R.S.
Sir John Wolfe-Barry, K.C.B., LL.D., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Dugald Clerk, D.Sc., F.R.S.
Alan S. Cole, C.B.
Edward Dent, M.A.
Sir Robert Abbott Hadfield, Bt., D.Sc., D.Met., F.R.S.
Major Edward Humphrey Manisty Leggett, R.E., D.S.O.
William Henry Maw, LL.D., M.Inst.C.E.
Sir Robert William Perks, Bt.
Sir Francis Taylor Piggott, M.A., LL.M.
Professor Arthur Schuster, D.Sc, Sc.D., Ph.D., F.R.S.
James Swinburne, F.R.S.
John Augustus Voelcker, M.A., Ph.D., F.I.C.
Frank Warner.

TREASURERS.

William Henry Davison, M.A.
Carmichael Thomas.

SECRETARY.

Sir Henry Trueman Wood, M.A.

SOANE TRUSTEE.

Alan S. Cole, C.B.

On the motion of the CHAIRMAN, a vote of thanks to the scrutineers was carried unanimously.

MR. WILLIAM E. OAKDEN asked if it was possible to publish a brief history of the Society in the *Journal* for the information of new Fellows of the Society.

THE CHAIRMAN said that this had already been done in Sir Henry Wood's "History of the Society of Arts," which was an excellent book. He did not think it was possible to condense a record of 163 years' work into a short article.

SIR HENRY TRUEMAN WOOD asked permission to be allowed to propose a vote of thanks to the Chairman for his services as Chairman of Council during the past two years. Not only had Dr. Dugald Clerk carried out all the regular routine duties of the office, but he had afforded him as Secretary the very greatest help in conducting the work of the Society, and had been specially helpful both as a contributor to the proceedings and in obtaining other papers for the Society.

LORD SANDERSON, G.C.B., K.C.M.G., was delighted to second the vote of thanks to the Chairman, and spoke of the great value of Dr. Dugald Clerk's papers and of his two inaugural addresses, which he considered were of national importance.

THE CHAIRMAN, in acknowledging the vote of thanks, said he had spent a very pleasant two years in office, and it had enabled him to obtain an insight into the work of one of the oldest institutions in the country. He had always taken a great interest in economic matters, and could see what an important part the Society had played, and the enormous influence it had had, in promoting the prosperity of the country.

The meeting then adjourned.

ARTS AND CRAFTS.

Posters and Decorative Art.—The little exhibition of posters at Messrs. Heal's Mansard Gallery is being held rather opportunely. The hoardings are for the most part empty, although evidently a few long-dated contracts are being allowed to run their course, and it is well that we should be reminded of the tremendous strides which have been made in poster design and production within recent years. The show at Tottenham Court Road consists mainly of posters for the underground railways, for whom some of the very best modern work has been done, and it is interesting both to have the opportunity of seeing so many of the designs collected in the same place and also to learn the names of some of the artists whose work is either not signed at all or signed in such modest fashion that it is not easily decipherable; but it also includes nine large lithographs produced under the direction of Mr. F. Ernest Jackson

by members of the Senefelder Club and others and three posters, produced as souvenirs for the troops in France and designed by Messrs. George Clausen, R.A., Charles Sims, R.A., and F. E. Jackson. The technique and the method of the works varies pretty considerably—a fact which is in itself of some considerable interest; and since in many cases the artist's original drawing is shown as well as the printed poster, it is not difficult to judge how far the process of reproduction has made or marred the final effect. Satisfactory as pictures like Mr. T. R. Way's landscapes and other works of the same class are from many points of view, and admirably fit as they are for reproduction, one cannot but feel that for the primary purpose of poster work—the catching of the eye and of the attention of the casual passer-by—those designs which are planned for a vivid but simple colour scheme are the most suitable, in spite of the fact that as regards faithfulness of reproduction it is very often just these pictures which have lost most of the real purpose of the artist. It was, of course, interesting to see the originals of Mr. Tony Sarg's pictures and to be able to study on a convenient level Mr. Macdonald Gill's fascinating underground plan of London; but it is perhaps the more recent works which give the show its really distinctive character. Posters like Mr. Maxwell Armfield's clever design of a gorgeous poll-parrot standing almost on its head amongst flowers of brilliant hues and calling out "Go to Kew" and some of the drawings of Mr. S. T. C. Weeks and other artists are more than clever advertisements—they are striking examples of the work of the modern movement in art. Not only in poster work, but in all branches of decorative design, there is at present a movement in favour of pure bright colour and of breadth and simplicity of treatment. How far this method is suitable, say, for the decoration of the home is a question which different people will answer in very varying ways; but there is for good or ill a quantity of this kind of work about, and it is perhaps as well that we should all of us realise its intimate connection with the ideals of poster design. We have suffered a good deal from over-elaboration and a sort of spurious over-refinement in design and decoration, and the present tendency is perhaps a natural, and in so far a healthy, reaction; but there seem to be two dangers connected with it. In the first place, the rather formless drawing which characterises a good deal of the up-to-date work, though it can give quite wonderful results in the hands of someone who really knows how to draw, leads very often to the wildest distortion when attempted by the novice or the amateur. In the second place, simplicity and directness are beyond praise; but, as in manners so in art, they may very easily when consciously and deliberately encouraged degenerate into brutality. If a poster is somewhat brutal it does not matter; its work is, to put it vulgarly, to "hit people in the eye"; but it does seem quite possible that if we surround ourselves in our homes and in our daily lives with a kind of art in which there is very little subtlety or refinement we shall be degrading rather than elevating our taste, and shall be losing at any rate some part of that civilising and refining influence which it has throughout the ages been looked upon as part of the mission of art to spread. Design and decoration in this country need fresh air and fresh life, and any movement which will bring these necessaries to them is to be welcomed; but there is after all as much danger of convention amongst the most pronouncedly unconventional as there is amongst the most commonplace, and at the present day, in art as in other spheres, we are perhaps more in danger of accepting new conventions carefully labelled "unconventional" than we are of falling in too readily with the old ones.

The Allied Artists' Association.—The exhibition of the Allied Artists' Association at the Grafton Galleries does not contain much work which has any connection with Arts and Crafts. The posters outside the gallery prove the sympathy of the society with modern movements, and are direct and forcible if not exactly beautiful. In colouring and in treatment they rather prepare one for Mr. Alfred A. Wolmark's somewhat garish painted pots shown in the first room, the colour of which suggests at first sight painted wood or metal or, indeed, almost anything but pottery. The nursery pictures and book designs by C. and P. Forbes-Robertson are also thoroughly direct in method and to some degree of the poster type; but their colour, though bright, is not in the least crude, and they are characterised by such light-hearted fancy and such an absence of the spookish element so often to be found in such work, that they are altogether admirable for their purpose, and ought to be the joy of any nursery happy enough to possess either the original drawings or reasonably good reproductions of them. The rest of the applied art exhibits were of a more ordinary kind. There is a barbaric quality about some of Mrs. Bethun's metalwork which gives it a certain interest, and Miss Ethel Virtue's jewellery is marked by a very lavish use of semi-precious stones, but the work in this section is not on the whole in any way remarkable. Miss Lottie Braxton Hicks's illuminations are simple and well arranged, but she is a good deal happier in her treatment of semi-uncial writing than of her Roman capitals. The headings in this character are not nearly so well spaced as the body of the writing.

Wounded Soldiers and the Artistic Crafts.—The exhibition of the work of wounded soldiers and

sailors which was held in Messrs. Sotheby, Wilkinson and Hodge's new galleries for a week recently was the occasion for the bringing together of a most interesting and creditable collection of work, but it opens up rather a large question connected with the artistic crafts. The exhibits consisted for the most part of objects executed by wounded service men who were supposed not only to be employing their spare time, but more or less fitting themselves for their return to civil life. Only a small proportion of them are connected with art at all. It is not easy, of course, to overstate the difficulty of such work, and, further, there is no doubt that it is better from every point of view that wounded men should be provided with occupation of some kind and not be left in hospital with nothing to do or dependent on the tender mercies of amiable ladies who try out of the kindness of their hearts to amuse them. Most healthy-minded people like to feel that they are really doing something themselves and hate being entertained. On the other hand, if wounded men are to be prepared for industrial life in trades or crafts into which art enters, they would seem to require teaching on a far higher artistic level than they appear to be getting. There are, it is true, some notable exceptions—the Lord Roberts workshops, to mention only one instance—but in far too many places the men appear to be allowed, if not encouraged, to do craftwork which is artistically on a very low level. This would be a pity even if the work were only regarded as occupation and recreation for the worker: when it comes to be regarded from a more practical standpoint the position is really rather serious. The majority of the artistic exhibits, whether embroidery, woodwork or metalwork, were of the kind which might have been seen in quantities at any bazaar or sale of work before the war. Whoever encourages wounded soldiers to do work of that type will be doing them poor service economically as well as artistically. If the stitching or whatever it may be of wounded men learning with difficulty to adapt themselves to their altered condition were poor or even bad there would be nothing to say—such a state of things would only be what might have been expected; but the execution on the whole was wonderfully good; it was the taste, which in the beginning at least might be expected from the teacher rather than the Tommy, which was to seek. What there was of it seemed normally to be about on a par with what may be found in work carried out in a very ordinary workhouse under the Brabazon scheme. It was nowhere near the standard of a good class held in pre-war days in connection with the Home Arts and Industries Association. This is the more to be regretted in relation to the embroidery, as men as a rule make really clever embroiderers. We all know of the men needleworkers of the East: some of us have marvelled at the skilfulness of male embroiderers so near home as Brittany—to say nothing of Belgium. If these men are to be taught crafts of this order, they should at least be given the opportunity of doing something more interesting than the ordinary type of fancy work. If they find regimental badges more to their taste than other designs, all well and good; but those badges should be as well drawn as possible. To train wounded soldiers in artistic crafts may or may not prove in the long run to be practicable; if they are to be trained in them at all, they should from the very beginning be taught in the best possible way—to aim at anything less is to court disaster. It is, of course, inevitable that in launching schemes of these kinds the promoters should have in the initial stages to feel their way and to make many mistakes. In this case, what they have achieved is in many respects remarkable; but in order to be really successful it must be more remarkable still.

GENERAL NOTES.

THE SCIENCE MUSEUM.—The report of the Science Museum for 1916 shows that although the Museum has been closed to the public since March 6th, 1916, it has been kept open to students, and facilities have been afforded to all who wished to refer either to objects in the galleries or to books in the libraries. The total number of visitors, which had risen to 350,000 in 1915, fell to about 95,000 last year. Many interesting additions have been made to the collections, among the most important being the gift of Mr. A. A. Campbell Swinton, F.R.S., of vacuum tubes relating to his researches in 1896–8 on cathode and Röntgen radiations; the loan of a model of Keadby Bridge on the Great Central Railway, which has a lifting span with a total weight of about 3,000 tons—the heaviest hitherto constructed in Europe; a Bisschop early gas-engine; and a number of models of plant used in connection with mining and metal lurgy, and naval and marine engineering.

SPAIN'S ESPARTO GRASS.—The British Vice-Consul at Aguilas, says the *Board of Trade Journal*, reports that, owing to limitations of export to the United Kingdom, the quantity of esparto shipped from Aguilas in 1916 was small. As a result of the restrictions and of the high freights ruling, an important development took place during the year, namely, that several Spanish paper-mills gave esparto a trial. There seems to be no doubt, adds the Vice-Consul, that esparto for paper-making will be largely employed in Spain in the future. Furthermore, a much larger quantity of the grass has been employed for making cords and ropes, with the result that, in spite of the restrictions on shipments, stocks of esparto in Aguilas were very low at the end of 1916.

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FRIDAY, JULY 6, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Wednesday, May 17th, 1917; The Right Hon. Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G., late Governor of Bengal, in the chair.

The paper read was—

DEVELOPMENT OF BANKING AND THRIFT IN INDIA.

By A. C. Chatterjee, I.C.S.,
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Of the many problems connected with India that have come to the fore during the course of the war, none is so important, and perhaps none is so complex, as the question of the economic or material development of the country. Proud as we Indians are of the share that India is taking in the great struggle, it is still a humiliation to many of us that the contribution in men and material has not been infinitely larger than we have been able to afford. It is the earnest hope of all of us that if ever in the future India is called upon to defend and conserve her liberties from external aggression, India's own effort, apart from the assistance that she will receive from the United Kingdom and other units of the Empire, will be more commensurate with her history, the immensity of her population and the vastness of her potential wealth. In order to prepare for such a contingency, it is absolutely necessary that all possible measures should be adopted for the ordered organisation of our manifold resources.

Even if we leave the problem of defence entirely out of account, there are other and urgent reasons for an immediate and sustained effort to increase the income of the people of India. Our poverty is now fully recognised. As Mr. Moreland has very clearly put it in an article in the current number of the *Quarterly Review*, "it is a matter of common knowledge that the standard of life in India is undesirably low; that while the masses of the people are provided with the necessities of a bare existence, they are in far too many cases badly housed and badly clothed, badly doctored, and badly taught, often overworked and often underfed; and that the present income of the country, even if it were equitably distributed, would not suffice to provide the population with even the most indispensable elements of a reasonable life." Our main dependence for several generations now has been on our agriculture, but the recent remarkable applications of science to the agriculture of all the older countries of the world, together with the opening out of the extensive prairies of new countries, has already threatened our position in the world market for agricultural goods, and the problem is likely to be far more acute in the near future. In industries, the revolution in processes of manufacture and organisation that has been in progress in the Western world for more than a century has wrested from us the pre-eminence in certain commodities that was ours from the early days of the Roman Empire. Our industries need development, not only to replace what has decayed, but also to supplement and reinforce our agriculture. Altogether, humanity in India has to be raised to a much higher level of efficiency and well-being than what we have so far been accustomed to.

There is one common factor in the various departments of economic development to which I have just referred. Capital is needed for all of them. It will be readily conceded that neither education nor sanitation can be developed without the laying out of immense sums of money which will not begin to yield any tangible returns for almost a generation. A more immediate remuneration is likely in other necessary directions of State activity. Means of communication and transport will absorb very large funds for a long time to come. Similarly, more money must be spent on the expansion of irrigation, in

tracts like Oudh, while the full exploitation of our forests can no longer be deferred without serious detriment to the national welfare. Turning to the sphere of private enterprise, capital is the primary necessity for the development of industries, and here also large or immediate returns cannot be looked for. Additional capital is necessary for agriculture as it is for industries. A query that has often been put to me is whether we can forecast the period of time that will be required to make our co-operative agriculturists self-dependent and self-contained with respect to capital. Frankly speaking, I cannot foresee that this condition will ever be attained. It is true that as a result of the thrift inculcated by co-operation, the peasants will, within a measurable period of time, amass capital equal in amount to what they use now. But the capital that can be profitably utilised in their agriculture, even in the present stage of science, is almost infinitely larger than what is actually available, and we must not forget that science is progressive. It has also to be borne in mind that co-operation, while it teaches thrift, also enlightens the mind of the peasant, and makes him desirous and anxious to adopt new and improved methods which involve the investment of larger capital. A year ago the number of members in agricultural credit societies in India was over seven hundred thousand, and their total capital was a little under three and a half million pounds sterling. This gives an average capital of slightly less than five pounds per member. I think it will be no exaggeration to state that with proper training and organisation the capital required will come up to at least thirty pounds per member on the average. If the number of agriculturist families in India be reckoned as, roughly, forty millions, the funds required for financing agricultural processes alone amount to twelve hundred millions sterling. It is not possible to hazard even conjectural guesses regarding the outlay that will be needed for industrial and commercial development, or for such communal activities as education or sanitation.

It is my object to-day to draw your attention to this important aspect of the very large question of the full economic development of India. Until recently we had a comfortable feeling that the organisation of our material resources might safely proceed along lines of slow and steady growth, and that if sufficient capital for the purpose were not readily available or forthcoming in the country itself, it could at a price be obtained from the richer and more highly developed countries of the world. The far-reaching incidence of the war has rudely dispelled both these illusions. It is now universally realised that in the interests of India herself, and in the interests of the Empire, her economic progress should not be left to slow natural forces, and that the pace must be accelerated by well-conceived measures on the part of the State and of the people. With regard to the supply of capital from non-Indian sources, it is now abundantly clear that even if legislation does not actually prohibit, for a considerable time after the war, the export of capital from the richer countries of the world, their internal requirements will leave only a very small surplus to be shared between India and other undeveloped lands. The money that we may be able to borrow in London after the war will command a price which we cannot pay without seriously handicapping ourselves, and, although I am not in a position to speak with confidence on this point, I entertain grave doubts whether we shall be able to borrow here anything approaching the amount that we shall actually need immediately after the war is over.

The conclusion is irresistible that India must in the main rely on herself and look to her own resources for the capital required for her development. To avoid any misunderstanding, I may mention that this is a view which, so far as I am aware, has never been sought to be imposed on India from without, but is only in accordance with the new ideas of true self-help that have been generated of late in our country. The question now arises, What are our available resources for the capital that is needed? The answer naturally suggests itself—India should unlock her hoards of the precious metals. From the time of Pliny she has imported large, though varying, quantities of gold and silver. In his work on "Indian Currency and Finance," Mr. J. M. Keynes states that "during the sixty years (preceding 1913) India is supposed to have absorbed, in addition to her previous accumulations, more than three hundred millions sterling of gold (apart from enormous quantities of silver)" (p. 100). Where all this gold and silver have disappeared is one of the puzzles for the economic historian of India. I do not pretend to be ready with a solution; but, apart from the partial explanation furnished by Mr. Keynes himself (p. 154), viz. that "the recorded statistics of trade overland show a large balance against India, which is probably met by an unrecorded export of gold, silver bullion and rupees," we must not forget that down to the

middle of the eighteenth century India was periodically visited by bands of invaders who, in the majority of cases, left almost as speedily as they came after gathering extensive spoils in gold, precious stones and other treasure. Also, down to the beginning of the nineteenth century the pagoda tree of India was shaken for its fruit by numerous European adventurers. The costly industrial arts of India, some of which survive to the present day, must also have consumed large quantities of the precious metals. I do not deny that the gold and silver jewellery even now owned by our women will in the aggregate reach large dimensions, and I also believe that here and there individuals possess comparatively big hoards of gold and silver, while many similar and smaller hoards secreted away during the centuries of anarchy and insecurity now lie unknown to all and are permanently irrecoverable. But, apart from the jewellery of the women, I am rather sceptical about the existence among the general population of any hoards of substantial value, at least in the provinces with which I am familiar. I do not wish to imply that the average peasant in India does not possess a few rupees tucked away in the roof of his hut or some other equally likely spot. And if each person in India can be assumed to possess in the average five rupees in cash we get the respectable sum of 100 millions sterling.

Law and order, combined with opportunities of sound and profitable investment, are, as we shall presently see, bringing to light the hidden hoards of India, and the process is likely to be considerably accelerated in the near future. Hoarding, however, as much as saving for useful employment, is a habit that takes long to instil as also to eradicate. We shall certainly be better off than we are at present when the instinct of hoarding, either in the shape of coin or bullion, or in the form of jewellery, is completely overcome, but personally I do not consider that all our needs will be thereby satisfied. That is why I wish to see inaugurated as soon as possible an active and sustained campaign of national thrift through the length and breadth of the country. It is fortunate that the war loan now under flotation in India is practically originating a movement of national thrift, and it is to be sincerely hoped that the organisations called into being for this immediate object will be widespread and efficient, and that they will be maintained so long as there is need for capital for the purposes of national development.

Thrift is not an unknown virtue in India, and banking in its different aspects is by no means an exotic transplanted from the West. Students of our ancient civilisation are familiar with the numerous references in contemporary literature to the prevailing custom of deposits with bankers, the use of promissory notes, and the issue of letters of credit and bills of exchange for the purposes of internal and external commerce. The injunctions of Hindu lawgivers on the subject of usury afford a clear indication of the practice of moneylending by the State and by private individuals. (For authorities, *vide* McCrindle's "Ancient India," p. 69; Rhys Davids's "Buddhist India," p. 101; Barnett's "Antiquities of India," p. 130.) References to *sahas*, or bankers, are to be noted in the early Muslim annalists. Indeed, the extensive commerce that was carried on in the Middle Ages within India itself and with countries outside would have been impossible without fairly well-developed banking facilities. In the seventeenth and eighteenth centuries the East India Company made full use of the indigenous banking agencies, and even at the present day much of the internal commerce of the country is financed by Indian bankers, though it must be admitted that joint-stock banks are fast encroaching on their domain and their methods are not sufficiently elastic for modern requirements. It is also exceedingly doubtful whether Indian banking at any time financed industry or national development. But even in Europe the functions of banking were until recently strictly limited to providing for the requirements of commerce and the pressing necessities of the State. It is true that a substantial proportion of the capital used by Indian bankers has been owned by themselves, but it is equally true that they have freely received deposits from their clients and customers. A portion of such deposits is held at call and consequently free of interest, but otherwise interest has always been allowed on deposits confided with Indian bankers.

Premising, therefore, that the habit of saving for profitable employment is not contrary to the traditions of the Indian people, and that consequently there should be no insuperable difficulties in resuscitating this instinct in a more active and more widely-diffused form than in former days, we may examine the inducements for thrift that exist in India at the present moment. About six years ago Mr. Reginald Murray contributed to this Society an excellent and authoritative paper on "Banking in India," in which he furnished an account of our modern

banking system. Fuller histories will be found in the standard works of Mr. Brunyate and Mr. Keynes, and in the Blue-books annually issued by the Government. I shall, therefore, refer very briefly to the types of banking that are to be met with in India. We have first of all the three Presidency Banks, which enjoy certain special privileges accorded by the Government in return for services rendered. The capital of these three banks, which stood in 1880 at £2·33 millions, had risen in 1914 to only £2·5 millions, but the reserves during the corresponding period had increased from £·4 million to over £2·5 millions. The expansion in business has been even more remarkable. Non-public deposits, which stood at only £5·7 millions in 1880, were nearly £27 millions in 1914. The next class is that of the Exchange Banks with head offices outside India, some transacting the greater part of their business in India, while others have merely agencies in India. It is, therefore, unnecessary to quote figures of their capital and reserves, but it is worth noting that the deposits in India increased during our period from £2·15 millions to £20 millions. We now turn to the joint-stock banks with head offices located in India. The management of several of the larger banks of this type is purely British, but I believe that a substantial portion of the capital of such banks is owned by residents of India. In 1880 there were only three joint-stock banks with a capital and reserve of over thirty thousand pounds each. In 1914 the number was seventeen, and the aggregate capital and reserves of these larger banks had risen from £·14 million in 1880 to £2·6 millions in 1914. In the same period deposits increased from £·4 million to £11·4 millions. As a matter of fact, in 1912 the deposits had reached the figure of £18·2 millions. The banking crisis of 1913 and the disturbance caused by the war were responsible for the decrease. In addition to these larger banks there were, in 1914, twenty-five joint-stock banks with a capital ranging between six thousand and thirty thousand pounds, which held in the aggregate £1 millions in capital and reserves and £·84 million in deposits.

It will thus appear that in a period of thirty-four years, or roughly in the lifetime of one generation, the deposits held by the three main classes of banks have risen from £8·25 millions to nearly £59 millions. No doubt a very considerable portion of this additional capital has been contributed by British, Continental and American merchants in business in India, but I think it will be admitted by all that the amount of purely Indian deposits has increased beyond all previous expectations.

A similar striking tale is told by the statistics of the co-operative banks. The earliest regularly-constituted societies for agriculturists were established towards the end of 1904, but it was only in 1912 that a legal status was bestowed on the central banks which attract funds from the general public for distribution among registered societies. The aggregate of the paid-up share capital and deposits from individuals in these central co-operative institutions in June, 1916, was £2·2 millions. This is an achievement that cannot be pronounced anything but satisfactory, specially if it is remembered that this amount has been contributed by persons who do not expect and are not entitled to any loans. So far as these institutions are concerned, the capital available in normal times in the majority of provinces is now much in excess of the actual requirements of the movement in its present stage. Co-operative credit, if it is to take permanent root in the country, must be guided along carefully-guarded lines of development, and those responsible for the movement have wisely decided to prevent an exuberant growth at the cost of strength. Consequently deposits offered to the central banks have frequently to be refused and often returned. It has been suggested that the popularity of this class of investment is due to an idea that the Government is responsible for the solvency of these banks, but so far as my own experience goes there is no such general impression among the classes which actually invest in these banks. Personally, I attribute their success to the tapping of a comparatively new stratum of depositors through the instrumentality of directors and managers who command local influence and confidence.

It is naturally impossible for an outsider to form an accurate idea of the different classes of people who nowadays deposit money in the banks in India. I had special opportunities of gathering information with regard to co-operative banks in my own province, and official duty as Registrar of Joint-Stock Companies in the province between 1912 and 1916 obliged me to examine the books of some of the smaller joint-stock banks that came to grief during that troublous period. Most of the depositors in both these classes of banks were recruited from the urban middle or professional classes. Here and there one came across the name of a landed magnate, and there were a few genuine agricul-

turists. And this is only what was to be expected on *a priori* grounds. In the interior of the country the industrialists and the commercial classes can, as a rule, utilise all available capital in their own business, while the natural instinct of a landholder is to invest his savings in the acquisition of more land. I am firmly convinced that the saving and investing habit can be fostered and developed to an almost infinite extent among what I have described as the urban middle or professional classes, and also under certain conditions among the landed classes.

Besides the four types of banks I have already adverted to, there are the Government savings banks run by the Post-office. They were organised in the present form in 1882, and by 1914 the number of depositors was over a million and a half, and the sum at their credit approached 16 millions sterling. The credit of the Government among the masses of India no doubt accounts for this remarkable growth; it will admit of expansion with the adoption of more elastic methods than have hitherto recommended themselves to a department of State.

In addition to these recognised types of banks, we still have in the towns and villages the two classes of individual bankers or banking families, the Seths, or the big men, and the smaller moneylenders. In Bengal and in Madras new types of small corporations have been developed, known as *nidhis* and loan companies, but so far as I am aware their methods are similar to those of individual bankers. Within limits, both the bigger and the smaller moneylenders invite and receive deposits from persons reposing confidence in them. Of course, no figures are available. As I have said before, internal commerce is to this day very largely financed by the Seths, and the landed aristocracy usually resort to them when in need of loans. The village moneylender is still the financier of agriculture, and, in spite of the obloquy that is usually heaped upon him, continues to perform an exceedingly useful and important function in the State. Much as I dislike some of his methods, I should be sorry to see him improved out of existence at once. Perhaps my experience of the difficulties in the realisation, through the processes of our civil courts, of money owed by contumacious members of credit societies, has inspired me with some sympathy for the moneylender's point of view. Legislation has been mooted to check the malpractices of moneylenders, and I hope that the remedies adopted will not be too drastic, in which case they will either remain a dead letter or seriously dislocate the entire business of agriculture. There is some danger of confusing the position and functions of the rural moneylender of India with those of the class in this country which merely exploits the vice and extravagance of foolish and ignorant people. In my view, the existing evils of usury in India will disappear with the spread of primary education among the masses and with the expansion of the co-operative movement, which I trust will absorb the moneylenders among its depositors. Meanwhile legislation is required for the registration of moneylenders, compelling them at the same time to maintain correct accounts.

I have now briefly sketched the different types of banks and bankers in India with whom deposits may be made on terms more or less advantageous to the depositor. For a person not himself engaged in industry or commerce, other means are also available for the investment of savings. The first in importance is landed property. In India, as in all old countries, ownership of land carries with it an implication of social standing and prestige, while, owing to the still surviving traces of insecure times, land is also considered the safest form of investment. I may be accused of holding rather heterodox views on the point, but I have long been of opinion that a comparatively light assessment of the land revenue, specially in provinces where tenant-right is not strong or secure, unduly aggravates this land fever to the detriment of other and more productive forms of investment. I have in recent years frequently seen landed property purchased on the apparent basis of an annual return of less than 3 per cent., and on closer inquiry have ascertained that it was hoped to raise the actual return to 6 per cent. or higher. This state of things will probably be modified as soon as the clamant needs of local development throughout India bring about an enhancement of local taxation.

In the large commercial centres and in some provinces like Bengal, Government and semi-Government loans and other gilt-edged securities are the most popular form of investment. In Upper India they have been in lesser vogue, perhaps because there is no stock exchange or sharebroker outside the Presidency towns, and securities of this type can be sold or purchased only through a bank or through the post office. The same difficulty affects the popularity in the interior of the country of good industrial securities like jute or cotton-mill debentures and railway shares. Latterly several branch or

light railways have obtained in India all the capital they needed, and extensive advertisement has familiarised country investors with this form of enterprise. It is to be hoped that within a reasonable period of time respectable share and stock brokers will establish themselves in the more important commercial centres in the interior of India, and thus help forward the national thrift movement.

So far, practically all the different types of well-managed banks in India have restricted themselves to the financing of trade and commerce, that is to say, to the forms of banking business recognised as orthodox by the distinctively English tradition. I believe that European industrialists in India borrow from the banks comparatively insignificant amounts for purely industrial ventures, following in this respect the traditions of British industry. They have the advantage, in centres like Calcutta, of the "agency firms." These firms undertake the finance as well as the superior business management of industrial ventures, and to a certain extent perform the functions of finance corporations or industrial banks. The system is not entirely free from attendant evils, but a European *entrepreneur* in touch with the presidency towns has no serious difficulty in obtaining capital for a sound proposition. Facilities of this kind are not yet available in the interior of the country, though a promising beginning has recently been made at Gwalior under the auspices of a well-known London finance house. The regular banks, whether managed by Englishmen or by Indians, cannot, in view of the proportion of capital to deposits held by them, lend to industries with any degree of safety. But even in England there is now serious questioning as to the adequacy of banking facilities for purely industrial purposes. In indigenous India, where wealth and *entrepreneur* capacity do not always go together, it has been contended that a different system, more perhaps on the models of Russia and Japan, should be adopted and an industrial bank or banks should be organised with State aid or guarantee. The subject is too complex to be dealt with in all its bearings in the course of this paper, but it is difficult to see how the industrial development of the country which is now so earnestly sought after by the Government as well as by the people can be furthered without some modification of the accepted financial functions of the State. The Government of India have displayed, in the manifold risks that they have undertaken during the war, several instances of the two supreme qualities of confidence and imagination. They will be called upon in the interests of the country and the Empire to use these faculties even more after the war.

Another type of banking institution urgently needed in India is that of land mortgage banks. A few of the joint-stock banks used to do some business in land mortgage, but the recent crises have made them more cautious. It is not possible for the co-operative movement as at present organised to undertake the financing of large landed estates. I do not wish it to be understood that I have any sympathy with the encouragement of the landed classes in careers of vice and extravagance, but there is ample room for the investment of money in their estates for agricultural improvements which will yield an ample return, though only in the course of a long period of time. The obstacles in the way of land banks are not so formidable as in that of industrial banks. Long-term bonds on the security of the mortgaged estates will probably prove an attractive form of investment provided that certain technical difficulties are removed by legislation, *e.g.* the uncertainty that usually attaches to loan transactions undertaken on behalf of a Hindu joint family or a Musselman shareholder. The impulse in this case, as in many other forms of beneficent activity in India, has to come from the State, and it is to be hoped that the Government of India, which is now fully alive to the importance of agricultural improvements, will adopt early measures in this direction.

For some time past the question of a Central State Bank for India has been in the air. The Royal Commission on Indian Finance and Currency, which was presided over by the present Secretary of State and submitted its report a few months before the war broke out, without committing itself to any decided views on the subject, commended it as one which deserved early and careful consideration at the hands of a small expert committee in India. It seems to me that events are shaping themselves in a way that will leave the Government of India little option in the matter. For a long time to come the Government will have to rely on India itself for any loans that they may wish to raise for productive or development purposes, and a State bank will perform this function with much greater success than is at present possible. The co-operative movement is developing fast and, as was indicated in the report of the Maclagan Committee, will soon need an apex bank for the whole of India which will run smoothly only as a department of a State bank. If the Govern-

ment commit themselves to the development of the resources of the country through State-aided industrial banks, then again a central State bank will be needed.

Whether a State bank is established or not in the near future, legislation is urgently needed to safeguard the entire movement of banking and thrift in India from unnecessary and unwholesome set-backs like what took place in 1913. The events that happened then were foreseen by all careful observers, and it is noteworthy that in the summer of 1913, just before the panic occurred, the Government adumbrated proposals for banking legislation, and invited the expression of public opinion. Reform moves slowly in India, and the preoccupations of the war have led to a postponement of the measure. I venture to submit that it is unsafe to leave this matter as one of the numerous after-the-war problems. At the end of the war there may be a renewed impetus for speculative, ill-managed or dishonest enterprise. It is essential at the present critical moment that national thrift and sound banking should be encouraged by every possible means, and one of the means is to exterminate all doubtful pretenders to the name and prestige of a bank.

DISCUSSION.

THE CHAIRMAN (The Right Hon. Lord Carmichael), in opening the discussion, said it had given him great pleasure to listen to the paper, which he thought was even more valuable for the ideas that it suggested than for the statements of fact that it contained. There was a very general feeling that when the war was over there would be an attempt on the part of many people to induce others to invest their money in a speculative manner; and, from the little experience he had had in India of such matters, he thought there was very great danger in such a proceeding. He was, therefore, glad to hear that the question was being looked into by the Government of India, and hoped they would take the right steps to prevent speculative investments. He agreed with the author that it was essential that sound banking should be encouraged by every possible means.

MR. W. H. MORELAND, C.S.I., C.I.E., wished to urge the point that the peasants in India, taken in the aggregate, were such important people that they had a perfect right to be heard on the subject of banking or any other subject that in any way affected their interests. The question of banking certainly did affect them very directly. If the proposition put forward by the author was granted—namely, that India needed a larger income than she had at the present time—it was certain that a large proportion of the increase must be obtained from the land. Minerals and other natural resources would be very valuable, but the land was by far the most important, and one thing that had been made clear by half a century of economic investigation was that the land of India had been starved for want of capital. In saying that he was speaking of the agriculture of yesterday; but the agriculture of to-morrow had now to be thought about—the new agriculture of which India was just beginning to reap the first fruits, and the foundations of which had been laid in the last ten years by the scientific and economic work that had been carried out. In order to realise the possibilities in regard to agriculture that were now opened up before her, India must have capital. The peasants themselves could supply a good deal of that capital, but they could not provide it all, and they would need the help of every class and interest in India. For this reason he objected to insistence on hoarding, because hoarding was an offensive term, and they did not want to offend people who ought to help. It was better to avoid such dubious inferences and concentrate on the fact of the idleness of potential capital. Owing to a great variety of causes India kept a good deal of potential capital idle which, if circumstances were different, might be profitably employed. The Government kept a large amount of silver locked up in the various district treasuries, which would not all be necessary if the Government had a proper banking system; and at the other end of the scale there was the thrifty peasant who saved his five or ten rupees and kept them idle. If all that potential capital in India could be employed in useful work, economic development in that country would be materially assisted. But just as the Indian peasants preferred to obtain their water from a perennial river rather than from an exhaustible reservoir, so the land of India required to be fertilised, not so much by capital drawn from an exhaustible reservoir, such as the existing idle resources of the country, but by capital drawn from a great river — a veritable Ganges of the savings of every class in the country. India required savings banks to gather in all the small savings, so that they could be mobilised in one large sum; and insurance and provident societies, stock exchanges, and financing houses, and almost every conceivable kind of bank should be established in every part of the country where they could be made use of.

MR. B. ABDY COLLINS, I.C.S., did not agree with the author when he referred to the approaching development of scientific agriculture as though it would not be a good thing for India. Personally he thought India had more to gain from that development than any other country

in the world. One of the causes that had kept back India from going ahead as fast as she might have done was the fear on the part of the Indian Government to spend money freely. They treated expenditure on agriculture as though it were ordinary expenditure on administration, and they watched it as jealously as they did the charges for ordinary civil and military work. That, he thought, was a great mistake. Expenditure on the development of scientific agriculture should be treated in the same way as expenditure on cana's and railways, and if the Government could not provide the necessary capital out of revenue they should borrow it. He thought that neither industries nor agriculture in India would in the long run be able to obtain the capital they required without more direct intervention on the part of the State than had been usual in most countries up to the present time. The people of India, knowing very little of the modern organisation of industry, were very slow to put their money into companies or to advance it to private firms to be spent in industries that were new to India. That difficulty in raising capital was really one of the causes of the failure of the so-called Swadeshi movement eight or ten years ago. If a finance corporation backed by Government was necessary in this country—as the Government had now recognised it to be—much more would it be necessary in India, and he was inclined to think that it would there take the form of a large State central bank. One of his reasons for thinking this was that the co-operative movement, which, as time went on, would require more and more capital, would also need some large central institution for finance. One of the difficulties experienced in the co-operative movement was the management of its finances. All the agricultural societies required money more or less at the same time of the year; they used it for a certain time, and then put it back in the bank. Those provinces which had their own provincial bank, like the Central Provinces and Bihar, were already beginning to find great difficulty in dealing with their finances. As they wanted money for long periods they could not take it on current account, but had usually to take it for one year at least, and, as a result, for a portion of each year they had some money on their hands for which they were paying high rates of interest and which were causing a loss to the movement. It was difficult to see how they could ever manage their business satisfactorily without being linked up to the State treasuries, or, at any rate, to a large institution guaranteed by the State, which could use its money for other purposes than agriculture. If he might take an example from Germany, which had perhaps developed co-operative banking more than any other nation, in that country the Prussian State Bank was, at any rate until recently, the head of the co-operative movement, and a large proportion of its capital was provided by the State. It used its funds to a great extent in financing ordinary trade and commerce. That was one of the ways in which Germany had got over the difficulty, and he thought its lead would have to be followed in India.

MR. MORETON FREWEN said that in several papers recently read, as well as in the present one, he had been struck by the change of opinion with regard to the advantages of State action. He referred to the papers by Lord Dunraven on State Fisheries; Mr. Bigland, M.P., and Mr. Wilson Fox, M.P., on Empire development for revenue. India might be regarded as a great Socialist State, State Socialism being applied in every direction—State railways, canals and irrigation, forests, and many other things. He was a member of a small committee appointed to consider the development of the resources of the Empire for the purpose of liquidating the National Debt, of which committee Mr. Rudyard Kipling was also a member; and he had recently received from Mr. Kipling a letter written to him by the Conservator of the Forests in Madras, who said that if only the Resources Committee could secure additional railway mileage and some development of the forests in Madras, a magnificent return could be made for any money the State spent in that way. The paper they had listened to might be taken generally as an inculcation of thrift, and the question was how to increase the thriftiness of the 300 millions of very poor people in India. It was rather a shock to him when Lord Curzon, in his third Budget speech in Calcutta, estimated the gross income of the 300 millions of Indians at only £250,000,000 a year. This sum compares with £2,500,000,000 of annual income here enjoyed by a population one-seventh of India's. He could not conceive how a country so poor in capital resources as India could be financed at all without some great creation of wealth and capital under the ægis of the State. He thought the first thing India would require after the war would be some system of currency that was not, as now, absolutely rotten. In giving evidence before the Silver Commission in 1876, Mr. Mackenzie said that thrift in India took the following form. When a man had saved a few rupees he sent for the village silversmith, who melted them down and made a bracelet which was shackled on to the arm of the man or his wife. Mr. Mackenzie said that myriads possessed considerable property in that form, and Mr. Harrison, who was the chief authority on the hoards of the Indian people, said that their bullion hoards, largely in the form of these bangles, might be estimated at ten rupees per each man, woman, and child in India. The national thrift funds thus accumulated were destroyed by a stroke of the pen when the mints of India

were closed to the free coinage of rupees, for before that step was taken the people, in times of famine, used to melt their bangles down to be recoined into rupees. There were two great advantages in the people having their savings in the form of bangles—one being the safety of such savings; they could not be stolen. The other was the sobriety ensured thereby, as a peasant could not spend in drink an armlet on his wife's person. Both those points were entirely disregarded by the Government when they closed the mints to the free coinage of rupees. The Indian Government had a great crisis to face in the next six months. Commodity prices in this country had risen since the war 100 per cent.; thus everything that India exported sold here at twice the gold price it commanded before the war. Those great Indian trade balances, gaining rapidly in value if not also in volume, had to be liquidated by the sending of either gold or silver from this country, and the silver market of the world had been absolutely ransacked by the Government of India during the last twelve months. It had bought nearly 40,000,000 ounces of silver from China during that period, and had succeeded in obtaining nearly three crores' worth of silver from the hoards of the Indian people. It was impossible to see where the silver required during the next year would come from. The gold reserve of this country was locked up safely in the Treasury of the United States, but when that gold returned to this country it would be immediately shipped to India to defray the vast sums already owing to India. Was it conceivable that such a condition of currency as we had forced on India could possibly survive without a crisis in the world's monetary history such as had never been experienced before?

MR. N. N. SEN inquired whether the author thought the English Money Lenders' Act should be made applicable to the moneylenders of India.

LIEUT.-COLONEL F. S. TERRY said he had had some experience of the Indian peasants in Dutch Guiana, and knew what splendid labourers they were. They were very much appreciated in Dutch Guiana, and often accumulated savings and bought land in that Colony. India was in a magnificent position with regard to the defence of the country, being surrounded by friendly nations, but it was necessary for the people of India to be taught and helped to maintain their secure position.

SHAIKH MUSHIR HOSAIN KIDWAI disagreed with the author when he said that the assessment of the land revenue in India was comparatively light; he thought that, on the contrary, it was too heavy.

SIR CHARLES STUART BAYLEY, G.C.I.E., K.C.S.I., then proposed a vote of thanks to Mr. Chatterjee for his interesting paper, the resolution being seconded by SIR FREDERIC W. R. FRYER, K.C.S.I., and carried unanimously.

MR. CHATTERJEE, in reply, thanked the audience for their expression of appreciation of his paper. Mr. Collins was mistaken in thinking that he deprecated the development of scientific agriculture in India, as he was one of its strongest advocates. Scientific agriculture was absolutely necessary in India, especially in view of the threatened competition of other countries, and for its development an immense amount of capital was required. He was in entire agreement with Mr. Collins and Mr. Moreton Frewen on the subject of State aid. His views on that question were considered somewhat heterodox about ten years ago, but he was glad to find that opinion had greatly changed in favour of State aid in India. With reference to the hoarding of wealth by the Indian people in the form of jewellery, if five rupees was considered the average amount of wealth per head accumulated in that form or in cash, it only amounted to £100,000,000 altogether, and if ten rupees were taken as the average it only amounted to £200,000,000, which, after all, was a very small amount for the national development of India. He had said in his paper that there was some danger of confusing the position of the English money lender with that of the moneylender in India, and he did not think that the English Money Lenders' Act should be applied to India.

PUBLIC SERVICES IN CHINA.

The *London and China Telegraph* comments on the fact that, in spite of the political unrest in China, the administration of the country is in many respects carried on very successfully. This, of course, is manifested more in those departments which have the benefit of foreign assistance, such as railways, telegraphs and posts. The accounts for these services for last year have recently been submitted to the Cabinet, and it is of interest to note that in each case the receipts show an increase over those of 1915. Railway administration has been more carefully taken in hand during the last two years, and the good result is already shown in the last accounts. Better management has effected a considerable saving. The total amount of income derived from railways in 1916 was $61,994,942, which shows an increase of $4,831,600 as compared with the income of 1915. The total expenditure incurred by railways in the same year was $29,679,227, that is, $530,280 less than that in the previous year. Taking income and expenditure together, an improvement of $5,361,888 on the previous year's working is shown. The income from telegraphs and posts is proportionately satisfactory. In comparison with the figures of 1915, a total

increase of $7,349,274 in revenue resulted from the working of the three services in 1916. Other branches of the Chinese administration which do not show such good results could doubtless be vastly improved with foreign assistance; but, so far from this being welcomed, the tendency is to dispense with foreign aid, even where it is manifestly in the interest of China to have it.

INTERNAL-COMBUSTION MARINE ENGINES IN JAPAN.

The use of internal-combustion marine motors in Japan, up to the present time, has been confined chiefly to engines suitable for passenger launches and fishing boats, to heavy-duty, slow-speed, moderate-power engines, preferably built to burn kerosene or producer gas. Small pleasure launches, using high-speed petrol engines of 3 h.p. to 10 h.p., are found in Tokyo and the various ports.

The Japanese were quick to realise the value of the cheap transportation afforded by the use of launches on the rivers and canals of the larger cities. In Tokyo, launches with two or three trailers maintain regular service up the Sumida River and certain canals. They are separated by motors burning producer gas generated from coke. In a similar service in Yokohama the launches utilise semi-Diesel, kerosene-burning engines. There are also several launches plying between the mainland and the smaller islands of the Inland Sea. The number of passenger launches, however, is relatively small, and, in view of the rapid development in street railway transportation in the cities, it is not likely that the number will be increased to any extent in the future.

By far the greatest use of marine engines is in the fishing trade. As a rule, the engines are not used on the fishing boats themselves, but on vessels which visit the small villages in certain districts, collect the fish from the local fishermen, and take them to the cities. These vessels are of both Japanese and foreign types, but the predominant type is a round-bottom craft, 40 ft. or 50 ft. long, with a beam of 12 ft. to 15 ft., and a draught of about 3 ft. Some are schooner-rigged, but they usually rely upon their engines.

It is difficult, writes the United States Vice-Consul at Kobé, to describe any one boat as a standard, but in the usual type the engines used are slow-speed, heavy-duty motors, two-cycle, with one or two cylinders, and from 20 to 50 b h.p. These motors are usually of European or Japanese make, and burn kerosene or producer gas. The older models have heated carburettors for the purpose of vaporising the kerosene and are fired by electricity; but the later types use the semi-Diesel system of a hot bulb and fuel injection for vaporisation and ignition. The engines usually swing three-blade propellers of 24 in. to 28 in. diameter at the rate of about 400 revolutions per minute, and give the vessels a speed of seven or eight knots an hour.

As many of the bays and harbours of the Japanese coast are very shallow, these fish-collecting boats are often equipped with propellers which may be raised or lowered at will, by means of a telescopic rear strut and a universal joint on the propeller shaft just aft the stuffing-box on the exterior of the hull. The tunnel-stern construction for shallow water, with the propeller operating within an enclosed tunnel, has not yet been introduced into Japan.

Large-size Diesel engines have not yet been adopted to any great extent. The innumerable small islands that make up a large part of the Japanese Empire offer an extensive field for small trading vessels. This field is at present occupied by small steamers and by schooners of about 500 tons dead-weight, which depend upon their sails alone for motive power. These schooners could be advantageously equipped with Diesel engines for auxiliary power, but this has not yet been done on account of the limited capital upon which the owners of the vessels operate.

Several ironworking firms have recently undertaken the manufacture of marine engines in Japan, one of the most important being the Ikegai Iron Works of Tokyo. Its engines are of the two-cycle semi-Diesel type, and range from 3 h.p. to 50 h.p. in stock sizes. Larger motors are built to order. Below 30 h.p. the engines are single cylinder; above that, double. The engines have high compression and ignition is effected by injecting the fuel, in the form of a spray, against a hot bulb in the cylinder head. Although the system is the same as that used in other countries in engines operating on crude oil, the Ikegai engines are usually run on kerosene or other light oils only.

The principal manufacturer of producer-gas marine engines is the Hatsu-do-ki Seizo Kabushiki Kaisha (Internal-Combustion Engine Manufacturing Co.) of Osaka. The engines produced by this firm are of the four-cycle type, from 20 h.p. to 50 h.p., and of one and two cylinders. These engines are not kept in stock, but are manufactured as the demand arises. About fifty per year are produced. No small, high-speed petrol motors are manufactured in Japan.

Up to the present time, engines of German, Swedish, and English makes have dominated the market; but during recent years Japanese-made engines have been gradually superseding the European motors.

Japan, with its innumerable bays, rivers, lakes, and canals, would seem to be an ideal place for small pleasure launches and moderate-size cruisers; but in reality the number of such boats is very small. The reasons are—(1) the fact that the Japanese have not yet adopted boating as a sport, (2) the high price of motors, and (3) the high price of petrol.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Cotton under Control.—In the beginning of the war the imminence of a ruinous fall in raw cotton led the Liverpool Cotton Association to appoint a minimum price. Cotton has risen to almost five times the former minimum, and now that a maximum is necessary the situation is beyond unofficial control. The adjustment has been left to a board which has been authorised to fix prices, allocate quantities and determine the amount of machinery that is to be stopped. The responsibility is an unenviable one, for prices must be fixed high enough to attract raw cotton to these shores without preventing the export sale of manufactured goods. The employment of 500,000 workpeople, 55½ million spindles and 750,000 looms is in question, and the internal complications make even rough justice difficult to administer. The task should be easier for a control board vested with plenary powers than for a simple advisory committee. The cotton trade through its trusted representatives is regulating itself, whereas there are advisory committees that have had very little freedom of action left after Government requirements have been satisfied. The control is an emergency measure destined to disappear when the occasion is past, but it may be expected to leave indelible marks on trade history. It carries Government authority, and does in a drastic way what cotton spinners have long been trying to do by agreement between themselves. No lesson that the experiment teaches will be lost.

Woollen Organisations.—The industrial historian will have no difficulty in demonstrating that war conditions lent a great impetus to industrial organisation. The records of the wool industries alone should prove his case for him. The demands for higher wages to meet the higher cost of living, coupled with the scarcity of labour, have drawn employers round a common table in their own districts, even in the absence of a definite trade union among the workpeople. These causes have operated for so long that the districts have had to join hands in a common federation of worsted spinners. The interferences with trading also have rendered consultation necessary between competitors who have been brought together further by the conferences for the allocation of Government contracts. New combinations for dealing with trade problems have come into being on all hands among spinners, manufacturers, merchants and workpeope. Co-operative companies for handling minor articles are coming into life, and there are prospects of others to undertake the foreign sale of goods. Finally, a Wool Textile Association embodying most existing trade associations has been formed to undertake the representation of trade interests before the Government and its Departments. Thus a singularly unorganised industry has gained a new corporate character in a strikingly short space of time, and the movement implies, of course, inward as well as outward changes.

Furnishing Fabrics.—A larger employment of artificial silks in all forms of furnishing fabrics is to be looked for now that the principal producers of viscose silk have taken over the English mill producing the highest class of power-woven tapestries. The brilliancy of viscose fibre is one obvious qualification, and the durability of it as experienced in wear is much in excess of the estimates that might be formed solely from tensile tests. The brilliancy can be masked as required by twisting one artificial with one duller thread, or can be made much of in long floats of weft. The material will be still more serviceable when the permanence of its colours accords more closely with that of real silk, and all its progress shows it to be a fibre made to be perfected.

Fireproof Fabrics.—The munitions business is presumably accountable for reiterated inquiries for an uninflammable cotton cloth. The chance of supplying the want depends upon the standard of non-inflammability to be reached, and this is possibly higher than can be met by any of the regular methods in use for reducing the risk of fire without appreciably affecting the natural character of the goods. These methods were summarised by Dr. W. H. Perkin in his address to the Eighth International Congress of Applied Chemistry in New York, and they consist principally of treatments which do little more than protect cottons from a brief flash of fire, and which lose their efficacy after washing. Zinc chloride, a deliquescent salt, is temporarily effective, and so is common alum when locked upon the fibre by starch. Impregnation with sodium tungstate makes a notably effective protection until an opportunity occurs for dissolving out the chemical. Observation of innumerable results and the search for a fireproofing agent of more permanent character led to the employment of stannic oxide, derived by deposition from sodium stannate and ammonium sulphate. This rather expensive process is that known as "Non-flam," use of which has been presented to British manufacturers at large. A later patented process of the same inventors provides for impregnation with sodium aluminate, followed by exposure to an atmosphere of carbon di-oxide and steam. It is possible that in fabrics required for munitions purposes the ordinary restrictions would be relaxed, and that the effect of a process upon the colour and superficial features would be ignored if a thorough protection could be obtained.

Second-hand Khaki.—A price of 80*s.* per cwt., or fractionally more than 8½*d.* per lb., is

readily commanded by the rags of our Expeditionary Force, and the sale of them is limited to the fulfilment of Government orders. Given that the garment is of a certain age, its remains are worth more than the wool out of which it was made. The price warrants the pains that are taken in the salvage, and at a time when towards 15,000,000 yards of new khaki are being put upon order the second-hand value is by no means negligible. Could the whole remains of the new issue be salved and sold at the present limited prices, there would be a return of £750,000, a substantial part of which should in due course come back to the Treasury.

Card-clothing.—Somewhat to their own surprise, the card-clothing manufacturers have found their trade taken under close Government control for reasons related to the shortage of steel wire. Their function is to make wire bristles set in a fabric of cloth or leather for the cylinders of the machines which card or tease out fibres in preparation for spinning. Card-clothing in these days is made upon elaborate machines, but there are greybeards still alive who earned an exiguous payment in their childhood by inserting pins at so much a thousand into leather strips. The occasion is not quite the first on which the Government has interested itself directly in card-makers' affairs. Under Charles II. Parliament forbade the importing of foreign cards and wire, and said something of the prevalent practice of putting old wire into new leather. At a date presumed to be in Anne's reign the West of England woollen manufacturers complained of the sale of old cards by "hawking fellows" who corrupted the spinners, and sold at exorbitant profits cards made with second-hand wire. At that period wool-card making was practised in eighteen counties, from Cornwall to Northumberland, seven cities, thirty-three market towns, and five villages. The trade is now apparently confined to the West Riding and Lancashire, and is largely in the hands of one syndicate.

Primitive Looms. — Mr. H. Ling Roth's "Studies in Primitive Looms" (Halifax: King. 2*s.*) is a reprint of his paper from the *Journal of the Royal Anthropological Institute.* Faithful particulars are rendered of the several types of spool and of shuttle found in use at distant periods and places, with special attention to the tools and methods of the Ainus, whose implements are held to argue a higher order of ability than the race has always been credited with. It is as well that the particular modes adopted by particular peoples in tying and looping the cards of their looms should be set upon clear record, but it is to be feared that contemporary interest revolves around other points. The author refers constantly to "laze rods," following some local phonetic, but their name of lease rod more definitely connects them with the lease string and the lea, which is a division of the hank. The rods serve to leash or group particular threads together. It is necessary to insist that a thread of warp is not "a warp"; it is, in textile speech, "an end." The part is not the whole, and the warp is the whole series of warped threads.

OBITUARY.

SIR GEORGE C. M. BIRDWOOD, K.C.I.E., C.S.I., M.D., LL.D.—By the death of Sir George Birdwood at Ealing on June 28th, the Society has lost one of its most devoted supporters. Born at Belgaum in the Deccan, in 1832, the son of General Christopher Birdwood, he was sent to England at the age of seven, first to school at Plymouth, then to Dollar Academy, and afterwards, at the age of sixteen, to the University of Edinburgh, where he took his M.D. degree. In 1854, at the age of twenty-two, he was appointed to the Bombay establishment of the Indian Medical Staff. After a short period of military duty on land, he took part as a naval surgeon in the Persian War of 1856-57, for which he obtained the medal and clasp. Returning to Bombay, he did not see any active service during the Mutiny, but rendered useful aid in preserving the loyalty of the city during the Mutiny. Besides his work as an Army doctor and his private practice, he took a very active share in civilian affairs. He held Professorships at the Grant Medical College, Bombay; was Registrar to the University, Curator of the Museum, Secretary to the Bombay Branch of the Royal Asiatic Society, and one of the founders of the Victoria and Albert Museum and the Victorian Gardens, Bombay. He was also a J.P. and Sheriff of Bombay.

Failing health caused him to leave India in 1868, and he came back to England at the age of about forty, as he told his friends, to die. But as a matter of fact it was to commence a career of public usefulness which was to last more than twice the period of his Indian service. He never attempted to take up again the practice of his profession, but after a short interval he became a permanent official in the India Office. Beginning as an assistant to Dr. Forbes Watson, Reporter on the Products of India, he eventually succeeded him, though in a somewhat different capacity, being appointed to the post of Special Assistant in the Statistics and Commerce Department of the India Office. He held this office from 1878 to 1902. In this capacity he was brought into association with exhibition work, and he practically was in charge of, or supervised, all the Indian Collections from the Paris Exhibition of 1867 down to that of Chicago in 1893. He was given the C.S.I. in 1887, was knighted in 1881, and in 1887 he was made a K.C.I.E.

It was not until some little time after his appointment to the India Office that his association with the Society of Arts began. He was elected a member in 1875, and in the following year he read his first paper here on "Competition and its Effects on Education, with special reference to the Indian Civil Service." Three other papers followed: "The Native Press of India," in 1877; "Quest and Early European Settlement of India," 1879, and "Indian Pottery at the Paris Exhibition," in the same year. Of these distinctly the most important was the one on the Native Press. Since those early days he has never read the Society another paper, but he grew more and more closely associated with it until it became one of the main interests and objects of his life. He presided at numerous meetings of the Indian Section, and frequently at the Ordinary Meetings, while he was a constant attendant and a regular speaker at both. Besides this he contributed innumerable letters and articles to the *Journal* on topics ranging over India and the East, industrial art of every sort, botany, medicine, etymology, and folk-lore. The last of these was a letter which appeared in the *Journal* on the Mhowra tree, published on May 18th of the present year.

A few years after he joined the Society as a member he was elected on the Council, in 1878, and from that time to the present he has acted continuously on the Council in one capacity or another, with only such brief intervals as the regulations of the Society necessitate. He was Chairman of the Applied Art Section from 1887 to 1908, and a member of the Indian Section Committee from the date of his first connection with the Society, holding the office of chairman of the Section from 1886 to 1895. He acted as one of the Society's treasurers from 1905 to 1907. He also represented the Society as trustee of the Soane Museum from 1897 to 1917. His last appearance was at a meeting of members of the Council held on June 8th to consider the questions raised by the resignation of the Secretary. Only the very day before he died he wrote to a friend that he was "greatly worried" because he could not attend the Society's annual meeting, which was held on that day.

He was a voluminous and copious writer, sparing neither time nor trouble in his work. He left behind a vast mass of literature, but the bulk of it was in the form of reports, papers in the transactions of various societies, contributions to magazines, articles and letters in newspapers, and introductions, prefaces, or appendixes in books of others—for he was ever ready to help in this way anybody who asked him. His most important books may be said to be "The Industrial Arts of India" (1880), his "Report on the Miscellaneous Old Records of the India Office" (1879), and the beautiful illustrated book, of which he was only part-author, "Relics of the Honourable East India Company" (1909). The most characteristic of his writings was the volume consisting of a republication of various articles, which was issued in 1915 under the mysterious title of "Sva." Sva appears to be a Sanskrit word or syllable, and its mysterious character somewhat evaporates when it is reduced to the more familiar Latin equivalent *Sua*.

The range of his writings was as wide as his own interests. There was hardly any subject on which he was not prepared to write a pungent comment—often wise, generally humorous, frequently eccentric, and, especially of later years, inevitably outspoken. On art, especially all Eastern art, he was a genuine authority, as indeed he was on all matters connected with India. But he also possessed a vast store of recondite and out-of-the-way information on subjects the most diverse, and this was always at the service of his friends. Hence perhaps it came about that his knowledge was wide and general, rather than detailed and accurate, and he was a little apt to put implicit trust in any authority which favoured his own views on any subject.

Fluent and ready as was his pen, he would devote unstinted pains to revision and elaboration; but he was naturally averse to condensation, and he was by nature a little intolerant of criticism. For him anything fresh or unusual had a special charm, and his artistic soul cared little or nothing for scientific accuracy. Murray's immortal dictionary was to him an abomination, probably because it corrected or ignored the fanciful conceptions in the way of etymology in which his soul delighted. Paradox was to him a source of infinite joy. Perhaps this was the reason why he—a man of genuine but highly unorthodox religious opinions—took a delight of late years in dating his letters in accordance with some mysterious Calendar of Saints, the roll of which seemed to be known to him alone. But in all he wrote, and in all he said, there was a certain delightful inconsequence that gave it a special charm. Editors were always glad to get his notes, which were unlike those of any other contributor; and though they sometimes had to excise and condense, he never seemed to mind so long as the alterations and erasures were not forced upon his notice.

His personality was, like his writings, unique in the literal sense of that much-abused word. He had a host of friends and they all loved him. There was nobody like him—quaint, crotchety, generous and liberal to a fault. He was always ready to help a friend—even if the friend did not want his help—with his influence, by his pen, or out of a purse which could never have been over well-stocked.

With the natives of India he had a marvellous influence, and to those of them who came to England he was a staunch and valuable friend. He was himself saturated with Eastern ideas and appreciative of Eastern ways. Probably nothing gave him more delight than that, year by year, on his birthday his Indian friends used to decorate with flowers the bust of him, by Alfred Gilbert, which had been presented in 1900 to the University of Bombay—a

replica of which, by the way, is in the Society's possession. He had an intuitive perception of the character and nature of the East given to few Westerners, and a sympathetic insight into the Eastern mind which very few Englishmen ever get. He loved India and the Indians, and they cordially reciprocated the feeling. If "East is East, and West is West, and never the twain shall meet," it really did seem that for once they met and fused in the mobile brain and kindly nature of George Birdwood.

DEWAN BAHADUR V. NAGAM AIYA.—The death of Dewan Bahadur V. Nagam Aiya took place at Trevandrum on May 8th. He was born in 1850, and educated at the Maharaja's High School and College at Trivandrum, whence he graduated B.A. in 1870. Entering the service of the Government of Travancore, he was in 1876 appointed Settlement Superintendent, and he had charge of the first census of the State. In 1883 he became Dewan Peishcar of Trevandrum Division, an office corresponding to that of Collector in British India, and in 1911 he received the title of Dewan Bahadur. Besides carrying on his duties as a district official and conducting census operations, he served for many years as a member of the Legislative Council of the State. He also compiled and edited the Travancore State Manual, a volume similar in nature to the District Gazetteers in British India.

He was elected a Fellow of the Royal Society of Arts in 1896, and was also a Fellow of the Royal Historical Society.

GENERAL NOTES.

THE LONDON SOCIETY. — Monsieur Paul Lambotte, Directeur des Beaux-Arts au Ministère des Sciences et des Arts de Belgique, who delivered two lectures before the Royal Society of Arts in 1915 on "L'Évolution de l'École Belge de Peinture (1830-1900)" and "Constantin Meunier et les Sculpteurs Belges de son Temps," addressed the London Society recently on "Impressions of London." London, he said, gave to the stranger who came to it for the first time an immediate impression of great immensity, the proportion of everything combining to produce this effect. The characteristic traits of London, those wherein she differed from other great capitals, were her river, her parks, and some of her monuments, which were thoroughly British. But more than all she differed from other great capitals in the quality of her illumination, in the extreme diversity of her clouds and skies, in the density of her fog, which extended even to the suburban landscapes. London was the town which showed the greatest changes, the greatest varieties, that he knew. The beauty of Paris was found in its harmony and continuity. The seduction of London was in her antitheses, in her unexpected contrasts, in her amazing juxtapositions. The River Thames was a striking example. Here were grand monuments, magnificent quays, delicious parks, luxurious houses and hotels; and side by side, just over the river, the low tide disclosed a steep bank of slime, and there were hideous factories and chimneys, rubbish and detriment everywhere. Some of the bridges were remarkable specimens of good architecture; others were but means of crossing the water—rudimentary, sordid, frightful. One felt that for many generations the citizens of London had not comprehended with continuity the cultivation of the great merits of their admirable Thames. The London Society could not be better inspired than to preoccupy itself with schemes for a future Charing Cross Bridge.

THE UNION JACK CLUB.—An urgent appeal is being made on behalf of the Extension Fund of the Union Jack Club in the Waterloo Road. The club was built in honour of the heroes of the South African War. During the last two or three years the work of the club has increased tenfold, and the premises are no longer adequate for the wants of the soldiers and sailors who desire to use it. Its popularity is proved by the fact that during 1916 the number of men provided with sleeping accommodation in it was 241,056, while over half a million meals were served in the dining-room. In spite of these huge figures the managers are compelled to turn away nightly many tired men—often straight from the trenches or the North Sea—from sheer lack of room. When once the building is provided the club is self-supporting, as the men using it pay enough to cover the costs. The appeal is strongly supported by Sir John Jellicoe, Sir David Beatty, Sir Douglas Haig, Sir William Robertson, the Earl of Derby, Sir Edward Carson, and many others.

THE VACUUM VALVE.—By far the most interesting development of wireless telegraphy within recent years is that connected with the vacuum valve, says the *Wireless World*. Originally used solely as a rectifier of electrical oscillations, and thus serving as a sensitive detector, Dr. Fleming's valve has now been improved and perfected to such a degree that it can be made to serve in the triple capacity of rectifier, magnifier, and generator of continuous oscillations. By its aid signals which would otherwise be inaudible can now be amplified to almost any degree; by combining the amplifying and oscillating powers continuous waves can now be received immeasurably more efficiently than heretofore, and with suitably designed transmitting valves wireless telephony takes a step nearer to a commercial possibility.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

EXAMINATIONS.

The results of the Advanced (Stage III.) Examinations, held from May 14th to the 23rd, were sent to the centres concerned on the 12th inst. It is hoped to send out the results of the Intermediate Stage (Stage II.) about the end of the present month.

THE DEVELOPMENT OF THE PETROLEUM INDUSTRY IN ASSAM.*

By H. S. Maclean Jack.

Assam is in many ways the least known province in India. With the exception of the frontier provinces, it is the smallest in area and population of the main political divisions. It is situated in the extreme north-east corner of India, and is, therefore, as it were, rather off the main road of Indian life as a whole. Politically the province comprises the two valleys of the Brahmaputra and the Surma and the hilly region separating them. Geographically the names Assam and the Assam Valley apply to that portion of the valley of the great River Brahmaputra which extends from about the point where the river issues from the Himalayas and turns westwards again, as far as the place where it makes its great bend to the south to flow into the Bay of Bengal.

Assam has had a more or less chequered history. In the past, under its own rajas, it successfully resisted the Mohammedan conquerors of the rest of Northern India; but later it lost its independence to the Burmese, from whom we took it in 1826. It passed through a time of exceptional publicity when, united to a portion of Eastern Bengal by Lord Curzon, it was elevated into a Lieutenant-Governorship, and became the target of all the Bengali agitation. Later, as you will probably remember, the divisions were reshuffled, and Assam returned to its state of a small province under a Chief Commissioner, in which it has since peacefully rested.

The northern side of the Assam Valley is the great mountain range of the Himalayas, and the valley extends eastward as far as that curiously interesting country where all the mountains and the rivers seem to have been twisted from a course running east and west to one running north and south, and where, I imagine, there are as many geographical and geological problems to be discussed as anywhere in the world. The eastern Himalayas are not so high as the rest of the range, but they are still something quite considerable, and I think there can hardly be a finer view than the range of snow-clad mountains extending nearly half-way round the horizon, which can be seen from very many places at the upper end of the Assam Valley. The southward hills are much lower, the main range only reaching an elevation of about 4,000 ft., and at the foot of these hills where they merge into the plain are many indications of the presence of petroleum. These indications continue not only in many places in the Assam Valley, but also reappear in the Surma Valley, and also, I believe, down the Arakan Coast. It would almost seem therefore, though perhaps it is not very wise to draw these rather wild deductions, that these deposits may be in some way connected with the Burma deposits, and the very close similarity of the crude oils found supports this idea. In Burma, of course, the oil deposits have been known and worked for very many years, the Burmese themselves having established quite an industry before Europeans took the matter in hand. In Assam, however, which is much more thinly populated and has such very different local conditions, the industry is a purely modern development.

* From the *Journal of the Institution of Petroleum Technologists*, Vol. III. pp. 263-276, 1917.

But to return to the difficulties met in trying to obtain geological data—a steady and continuous search over years has produced a volume of evidence for consideration. Each point has been tested and considered, and in time, by rejecting some and accepting others, the preliminary problems have, I think, been solved, and it is hoped that a stage has now been reached at which the sites of the wells can be selected with some certainty. It may appear to you, and quite naturally, that a very long time has elapsed before arriving even at the modest result claimed. But if you will bear in mind all I have told you regarding the conditions of the country itself; that the work was being done in a new territory, with absolutely no previous geological knowledge or experience to guide those in control; the confusion which followed from different drillers deciding to call the same strata by different names, and with equal impartiality different strata by the same names; and also the slowness with which in consequence the data gathered by research and from drilling results were collected, you will, I think, appreciate the position.

The strata which are found on the fields consist of hard shales and clays of various sorts, including bands of a very soft spongy nature, and sandstone of all degrees of hardness. The beds usually dip at a sharp angle. The dip on one flank of the anticline is usually very much steeper than the other, in some cases being perpendicular, and sometimes it is actually overfolded.

In order that you may understand clearly the progress which has been made in the arrangement and equipment of the drillery, I think I will describe to you the condition of the fields at three different periods. All the original drillers employed by the company were Canadians, who used the Canadian pole system. Difficulties of drilling are, I suppose, of the same general nature all the world over, but the particular ones which were emphasised in Assam, and gave the most trouble, were the bands of spongy clay and the steep dip of the strata. Owing to the latter, where the drill suddenly came on a bed of very hard rock, it was very easy to get the hole out of the perpendicular. In that contingency the soft clays clasped the casing, making it an extremely arduous task to get through even 20 ft. or 30 ft. It was necessary to "work" the casing so frequently that sometimes it almost seemed that there was no time for drilling. The method of meeting the difficulty which was most in favour with some drillers was to let the first string of casing go and insert another. By this means the bands of clay were passed indeed, but often at the cost of not getting deep enough, or, when the oil was reached, the diameter of the last string was so small as to be hardly worth the cost.

The ordinary wells took an extremely long time to drill, and were very expensive as well; but time was of the two factors the one which we could least afford to lose. And at this time to drill an out-well, by which I mean an experimental well away from the main field, was almost unbearably slow. The only communication between the well and the main settlement was by elephant. All supplies, tools and casing for the well, coal for the boilers, everything had to be carried out by elephant to the site. If weather conditions interrupted supplies, which they frequently did, and coal ran short, wood had to be used, which merely gave out plenty of smoke and no heat.

For half the year working in the jungle was very unhealthy, and frequent sick leave had to be allowed for in all calculations. But time in proving territory, time in getting results, was of the very greatest importance. The work was being carried out for an ordinary commercial company, and shareholders are never anxious to obtain results for their grandchildren, but desire dividends for themselves, and do not hesitate to say so.

The better results which were immediately wanted could only be obtained by improved methods and more plant; more plant meant the expenditure of more money, and no more money could be obtained until improved results were shown, thus completing the vicious circle in which affairs had become entangled. However, it was obvious that extensive changes were necessary, and the company had to try to do what little their means allowed, partly by small increases in plant, but chiefly by improvements in methods. It was not easy, though, to get any new methods introduced, as the ordinary driller at that time was not a man who accepted suggestions gladly. The first actual alteration made was the sending out of a water-flush plant made by an Austrian firm styled Albert Fauck & Co. When it arrived on the field it was condemned by the drillers then in charge as being too small and altogether too weak for any effective work.

However, the reorganisation which was imperative was gradually pushed on and completed, and the drillery arrived in due course at what I might term the second stage.

At that stage the professional driller from Canada had been almost entirely dispensed with, though occasionally one or two were engaged for some special job, and the field was in the charge of engineers who had acquired the whole of their experience of drilling in the company's service. They acted as supervisors, and natives, who had also been trained on the company's fields, were in actual charge of the wells. These natives were of various races, and they have shown themselves quite as efficient as the Canadian drillers, and the company has several now whom it would unhesitatingly employ on out-work without any European control.

As to plant, ropes were substituted for the Canadian poles. The ordinary manila rope used in America was not adopted, but experiments were made with steel wire-rope, and with a reasonable amount of success from the very first. After a few trials with different "lays" and "makes" a rope was chosen which for some years now has given every satisfaction. Also, there was a general strengthening up and improvement of tools and other details all round. Then a very great effort was made to avoid the trouble which I have already mentioned, carrying each string of casing to the greatest possible depth, and this was fairly successful. But at first it only brought another trouble in its train, as it was found that the 7-in. and 8-in. casings, which were attaining depths they had never done before, were not strong enough. They took to collapsing suddenly, and on one or two occasions a well was lost in this way. After some theorising, the practical solution of thickening the walls was adopted with satisfactory results. Also, in order to facilitate the drilling of new wells away from the main field, the directors decided that for the future the construction of a railway line was always to precede the actual work of proving a new area, thereby ensuring that a proper service of supplies could be kept up.

Another alteration made was to send out steel rigs and derricks from this side. Previously the rigs had been made of timber cut on the spot; but timber in Assam is never very satisfactory, and the longer the well took to drill, the greater the chance of the whole thing coming down on the driller's head before he had finished—which it actually did on very many occasions. Quite apart from any other difficulties which might result when the derrick collapsed, by the time another had been built the casing, of course, had set fast, and one of the things it was most wished to avoid had occurred. The new rigs were designed by the general manager, and though, perhaps, they are slightly on the heavy side—certainly they are as compared with similar American derricks—they have done excellent work and stood up to every demand made on them.

All these improvements combined enabled a well to be sunk with reasonable certainty and of satisfactory diameter in about one-third of the time which it had previously taken—an advance which did great credit to the staff, and which I think they were entitled to regard with considerable satisfaction. And I should like to repeat that both the European and native staff were men who, with the exception of the field manager, who had made occasional visits to Burma, were trained entirely on the company's own field, and had never seen drilling methods elsewhere. The results they were competing with were those obtained by trained Canadian drillers working with tools, plant and methods of their own selection. In a few years and in every branch matters had been improved out of all recognition.

Naturally, the company was not entirely contented even with this, and, selecting the clays as the strata which gave the most difficulty in drilling, sought to find a remedy for them; and this brings me to the third stage of the drillery development. A Parker rotary plant was sent out with American drillers in charge, and this plant has been a complete success, in fact the company have increased it recently. The rotary can deal with clay with the greatest possible ease. But the interspersed sandstones, which up to then had been treated almost with contempt—that is, the drillers used to look forward to getting into the sandstones in order to make headway with reasonable speed and a minimum of trouble—gave everyone an unexpected surprise. All these things were comparative, and it was certainly the impression that what was called "rock" in Assam was really something almost soft. The American drillers now say that it is some of the hardest they have ever encountered. The ideal for work in Assam is undoubtedly to use the rotary for the soft strata and the percussion system for the hard; but we have not yet evolved a satisfactory combination rig for this purpose, and the average progress made by the rotary is so good that it is certainly not at present an urgent necessity to deal with the problem.

The present position is that both rotary and percussion drills are going. The fastest drilling

the company has yet done with the rotary is 500 ft. in four working days; the slowest marked was 1 ft. in ten hours. With the percussion system, about the most ever done in one day was 40 ft., and 20 ft. to 25 ft. a day was considered good progress—in fact. that would be an average which was seldom maintained. In attempting to get through clay beds, very often the advance for a fortnight would only be about 20 ft. It may also be interesting to mention that when both the American drillers who went out with the original rig left at the end of their agreement, the rotary was worked by the native staff, and equally good progress was made. One well under a native has actually done over 100 ft. in a day. One of the Americans has, I may mention, since rejoined. and is supervising the work of the natives who are actually in charge of the rigs.

I have now dealt with all the preliminary work, and have arrived at the point where in a logical sequence I should describe the actual oil obtained. The crude petroleum in Assam is found in intermittent deposits situated in loose sands. Considerable gas pressures are present, and on first striking the oil the well usually flows with a good deal of force. In most cases it will continue to blow at intervals for many months, and it is not until the well has reached a mature age that pumping is necessary. As an example of the gas pressure, recently when oil was struck at a depth of about 900 ft., in a well being drilled by the rotary, the whole of the column of mud in the hole, together with all the tools, was blown out, and the well flowed for some little time.

No one of the company's wells has proved to be a really heavy producer, and, according to the theories which have been formed, the field is not likely to provide any big gushers; but we are quite willing to have this theory falsified. On the other hand, the wells are very good stayers, and remain reasonable producers for a comparatively long period. When the oil reaches the surface, it brings with it a considerable proportion of sand, and one of the natural constituents of the oil is a heavy percentage of wax of a very high melting-point. As one might expect, therefore, the wax and sand combine to choke the well, and at fairly frequent intervals form a very hard plug. A special gang is kept constantly at work cleaning the wells as they choke, and keeping them generally in order.

The pure crude is ·856 sp. gr., and appears of a very dark brown, almost black colour, by reflected light, without the fluorescent greenish tint common to many American oils. By transmitted light at 84° F. the colour is warm sienna, and the oil is quite transparent and free from suspended particles of extraneous insoluble matter. If the oil is allowed to evaporate spontaneously on a microscope slide, under favourable conditions as to temperature, a ½-in. objective shows no distinct crystals, but by the use of an 8-in. objective clusters of very minute lamelliform crystals, some foreign substances, and what appear to be parts of organic structures, become distinctly visible, embedded in a transparent yellow oil. The oil is perfectly fluid at 82° F., but at 81° F. crystals of paraffin begin to form and settle. These crystals are separate and defined; they do not agglomerate into a solid cake, but can be easily diffused through the oil by slight agitation. At 77° F. the oil loses fluidity and becomes semi-solid.

I do not think that there is anything exceptional about the methods of distillation. The system used has been worked out and evolved by the management in practice as the system best suited to the crude oil, and to the company's particular requirements. Owing to the distance of the refinery from all sources of supply, and the consequent heavy cost of imported chemicals, it has been of the greatest importance to reduce the use of cleansing and other agents to a minimum, and the whole process is actually carried out simply by careful distillation and cuts at the worm end. The crude oil, after having been pumped from the drillery, is settled in tanks, from which it is pumped into boiler stills arranged in groups of three. In the boiler stills the distillation is continuous. From the first still crude benzine is taken off, about 750°–770°; from the second still intermediate kerosene, and from the third the bulk of the ordinary kerosene. The residue is distilled to dryness in pot-stills, and in these a continuous feed is not usually resorted to. The distillate from the pot-stills starts and finishes a very bad colour, and these portions are cut out and redistilled later. The whole of the middle distillate is passed through the refrigerating plant. The plant has both an anhydrous ammonia machine and carbonic acid machines, and in practice it has been found best to pass the oil through both in succession. From the former is obtained the bulk of the wax of high melting-point, and from the latter the basis of the batching oil. Batching oil, I may say, is oil used for softening jute fibre in the process of manufacture.

The range of products is as follows: The

non-condensable vapours are conveyed from the worm ends to the furnaces and used as fuel. The crude benzine obtained from the boiler stills is redistilled in closed steam coils, and two qualities of petroleum spirit are produced, having specific gravities of ·710 and ·750. It could be wished that the demand for spirit were very much greater than it is at present, as it does not absorb the supplies available. There is the usual consumption for motors, but in India this is small. In order to stimulate sales, the company has taken a considerable amount of trouble in developing a demand for lighting, the system used being the conversion of the spirit into vapour, to be burnt with an incandescent mantle in the manner probably well known to all of you. The efforts in this direction have been fairly successful.

The intermediate kerosene from the second boiler still is a colourless distillate, and gives an oil of very great power value in internal-combustion engines when slightly concentrated. A small quantity of water-white kerosene is produced for Europeans, but the great bulk of the kerosene product is absorbed by native consumption. It is a low-grade oil of about the colour of whisky, and smokes abundantly when burnt. Luckily the native consumer regards this as rather an attraction than otherwise. This tendency is attributed to the presence of the aromatic hydrocarbons.

Our batching oil is concentrated to ·885–·890 sp. gr. Very great trouble was experienced in hitting off the best method of getting this important product, and for many years the refinery was not successful in making anything suitable. Even now in appearance the oil differs very considerably from others which are sold. But in use it is understood to give very excellent results, which is the main thing.

Paraffin wax is one of the most important constituents of Assam petroleum, which resembles in this respect most of the Eastern oils. It is hard wax of very high melting-point, and the percentage in the crude is considerable. The melting-point adopted as a standard is 135° F., but during the greater part of the year the difficulty is to obtain the softer waxes to blend down to this average. A melting-point of 140° is quite normal for a run of wax; and when required for exhibition purposes, or something similar, wax of a melting-point of 145° and higher has been produced with no difficulty whatever. It is customary for the company to market the wax in a semi-refined state—a bright lemon-yellow in colour.

When distillation has been finished, 8 in. to 12 in. of coke is found in the pot-still. This coke is 97–98 per cent. pure carbon, and at present it has to be used as fuel under the sills. It would prove a marketable product, I believe, if only the refinery were situated elsewhere; but under present conditions the freights to be paid are against it, and make the selling impossible. The refinery management by careful methods have succeeded in reducing the waste in distillation to about 5 per cent. of the crude, which I think is a result reflecting great credit on them.

As to distribution, the only pipe-lines we have are those actually on the drillery itself and from the drillery to the refinery, all quite short distances. The refined products are moved in tins, drums, or in bulk on the railways, and the batching oil for Calcutta is taken down the river in bulk flats.

Well, we have now gone systematically from the first notices of oil in Assam, through the preliminary drilling difficulties, up to the results which are at present obtained in the refinery. Eighteen years ago, though the Assam Railways and Trading Co. had an experimental refinery and was testing the best methods of dealing with the crude, it may be said that, from a practical point of view, no oils were being produced in Assam. The local production now supplies the whole of the Assam Valley with its wants of kerosene, and also helps to supply some of the most thickly populated districts in Eastern Bengal. The petroleum spirit is known all through the north of India, and the company takes a creditable share in the supplies of batching oil for the Calcutta jute market—the largest, I believe, in the world. The Assam paraffin wax is exported to all parts, and whilst it shares to the full the high qualities characteristic of most Eastern waxes, for one or two purposes it is preferred by users to any other.

As to the future, the company, of course, is not content to rest on the results which have been obtained up to now. The developments on the present fields are pushed on with energy, and careful exploration and search is being made in the neighbouring districts. It is expected that areas will thus be provided for future work. It must, of course, be admitted that as yet Assam plays only a very small part in the whole petroleum industry, but there are those connected with the company who are sanguine enough to hope that in time there will be developed in Assam an asset which will be

of very much more than merely provincial importance.

No paper on the development of petroleum in Assam would be complete without references to Sir Boverton Redwood, who has acted for very many years past as the company's technical adviser, and whose resourceful mind and unique knowledge of petroleum technology have always been at their disposal to meet the various practical difficulties which have arisen; to Sir Thomas Holland, who as geologist to the company has evolved the working theories of the fields, and now advises on their proper development; and to the general manager, Mr. A. B. Hawkins. Mr. Hawkins has been the chief official of the company for the last thirteen years, and during the whole of that time the sole management of local affairs has been in his hands. He has not only interpreted and given effect to the policy and instructions of the directors, but has himself initiated and carried out improvements both in the refinery and the drillery, and a large measure of the credit for whatever success the company has attained is due to him for the energy and intelligence with which he has performed his duties.

THE ARMY VETERINARY CORPS.

In the course of an article on the Army Veterinary Service, published in the *Journal of the Royal United Service Institution*, Major J. W. Rainey gives a very interesting account of the means taken to safeguard the health of the horses and mules in the British Army, and the figures which he quotes are a striking testimony to the efficient work carried out by the Army Veterinary Corps. The total wastage, he writes, among horses and mules of the British forces at home and in the Expeditionary Forces abroad, including losses from enemy gunfire and all other causes whatsoever, during the year ended December 31st, 1916, amounted to 13 per cent. of the total animal strength. The total wastage during the year 1912 (*i.e.* during peace) amounted approximately to 14·8 per cent. In other words, in spite of continuous losses from enemy gunfire and from the inevitable chances of war, the annual wastage among probably the largest number of horses and mules ever collected together has, during the last complete year of war, actually been less than the rate of wastage in time of peace; and this notwithstanding the fact that the bulk of the animals have been standing night and day in the open, exposed to all weathers, whereas in times of peace all Army animals are stabled under the best hygienic conditions.

It is interesting to compare with these figures the corresponding statistics of the South African War, 1899–1902, when there was no Army Veterinary Corps. The mortality among Army animals then exceeded 55 per cent. In the German South-West African campaign, 1914–15, when the Union Government included in their forces an Army Veterinary Corps, the annual mortality dropped to 9·09 per cent.

The work of the Army Veterinary Corps comprises:—

1. The examination for soundness of all animals prior to their purchase for the Army.
2. Care of remounts on board ship.
3. Prevention and control of contagious and other diseases among all Army animals.
4. Treatment of minor cases of sickness and injury under regimental arrangement with the unit to which the animals belong.
5. Evacuation to veterinary hospitals of all cases of sickness or injury that cannot be treated properly with the unit, or that, for military reasons, it is not desirable to retain with the unit.
6. Maintenance of an efficient standard of horse-shoeing throughout the Army.
7. Supply of veterinary medicines and equipment.
8. The training in schools of farriery of shoeing-smiths and cold-shoers required for the Army.
9. Careful observance of and advice upon all matters directly or indirectly affecting the welfare of the Army horse, *e.g.* stable management, forage and feeding, watering, etc.

Major Rainey gives an admirable account of these various branches of the service. Not the least interesting part is the diary kept by a veterinary surgeon of a voyage which he made in charge of nearly a thousand horses. This conveys a remarkable impression of the great and continuous care bestowed on the animals, which in this particular case was so successful that all the horses were landed safely, and that their condition, on the whole, actually improved on the voyage, in spite of the fact that the weather was very hot and the animals were at times much distressed by it.

CULTIVATION OF BRITISH RHUBARB.

The reading of Mr. J. C. Shenstone's paper on "Herb-growing in the British Empire" has drawn attention to the early efforts of the Society to introduce the cultivation of rhubarb into England. In 1763 the Society appointed a Committee to deal with the subject, and after various inquiries they awarded in 1769 gold medals to Dr. Mounsey, an English physician settled in Russia, for the introduction of the seed of the true rhubarb, and to James Inglish for plants raised from it.

A little later a gold medal was awarded to Sir Alexander Dick, President of the Royal College

of Physicians of Edinburgh, to whom the seed had originally been sent by Dr. Mounsey. Sir Alexander Dick wrote to the Society a full account of the circumstances which led to the introduction of the seed, and his letter is still preserved in the Society's records. It also formed the basis of an interesting description by Dossie in his "Memoirs of Agriculture" (Vol. III. p. 211).

It appears that Sir Alexander, by the help of his brother-in-law, Mr. Keith, British Minister at St. Petersburg, opened up correspondence with Dr. Mounsey, the chief physician to the Emperor of Russia and President of the Russian Chancery of Medicine, with a view to obtaining plants of the true rhubarb, which, according to Dr. Mounsey's best information, grew "within the Chinese Wall," which was vigilantly guarded. By the help of the Chancery of Medicine, such steps were taken that the Chinese vigilance was at last eluded, and a box of seeds of the true rhubarb was conveyed safely to St. Petersburg. Dr. Mounsey caused some of the seed to be sown in the Imperial Gardens. Sir Alexander Dick stated in his communication to the Society that it was to Dr. Mounsey alone that Britain is indebted for this valuable plant.

After the introduction of the plant other medals were awarded for attempts, more or less successful, to secure the growth of the plant on a commercial scale. Amongst others, a silver medal was given in 1789 and a gold one in 1794 to William Hayward, of Banbury, who carried on the cultivation of the plant for some years. After his death, in 1811, his plantation was purchased by Mr. Peter Usher, of Bodicote, near Banbury, by whose descendants the cultivation of medicinal plants has been carried on down to the present date.

Peter Usher was succeeded by his son Rufus, who introduced the cultivation of other medicinal plants, including *atropa belladonna*, *hyoscyanus*, the poppy, from whose capsules opium is obtained, and other plants. A very complete description of the plantation, as it existed in 1872, is given in the book "Pharmacographia: a History of the Principal Drugs of Vegetable Origin met with in Great Britain and British India," by F. A. Fluckiger and Daniel Hanbury, F.R.S. :—

"The authors of this book had the pleasure of inspecting the rhubarb fields of Messrs. Usher on September 4th, 1872, and of seeing the whole process of preparing the root for the market. The land under cultivation is about 17 acres, the soil being a rich friable loam. The roots are taken from the ground during the autumn up to the month of November. It is considered advantageous that they should be six or seven years old; but they are seldom allowed to attain more than three or four years. The clumps of root as removed from the field to the yard, where the trimming takes place, are of huge size, weighing with the earth attached to them as much as 60 or 70 lb. They are partially cleaned, the smaller roots are cut off, and the large central portion is rapidly trimmed into a short, cylindrical mass the size of a child's head. This latter subsequently undergoes a still further paring, and is finally sliced longitudinally; the other and less valuable roots are also pared, trimmed, and assorted according to size. The fresh roots are fleshy, easily cut, and of a beautiful deep yellow. All are dried in buildings constructed for the purpose and heated by flues. The drying occupies several weeks. The root after drying has a shrivelled, unsightly appearance, which may be remedied by paring and filing. The finished drug has to be stored in a warm dry place.

"When well prepared, Banbury rhubarb is of excellent appearance. The finest pieces, which are semi-cylindrical, are quite equal in size to the drug of China. The colour is as good, and the fractured surface exhibits pink markings not less distinct and brilliant. Even the smaller roots, which are dried as sticks, have internally a good colour, and afford a fine powder. But the odour is somewhat different from that of Chinese rhubarb; the taste is less bitter, but more mucilaginous and astringent, and the root is of a more spongy, soft, and brittle texture. The structure is the same as that of the Chinese rhubarb, except that, as already stated, the star-like spots, if present, are isolated, and not arranged in a regular zone.

"The drug commands but a low price, and is chiefly sold, it is said, for exportation in the state of powder. It is not easily purchased in London."

A few years later Mr. E. M. Holmes, Curator of the Museum at the Pharmaceutical Society, also visited Messrs. Usher's farm, and gave a full account of it in the *Pharmaceutical Journal* of June 16th, 1877. He supplies many details about the cultivation of rhubarb which are not to be found in "Pharmacographia," and also describes the cultivation and treatment of henbane and of the white opium poppy.

Richard Usher, a grandson of Peter and a member of the Society of Arts, exhibited at the Philadelphia Exhibition of 1876 and at Chicago in 1893, obtaining awards at both exhibitions. The farm is now carried on by the great-grandson of Peter Usher, Mr. Richard Usher, and is the most important one of its sort in Great Britain.

Before the foundation of the Society, attempts had been made to introduce the true medicinal rhubarb into England, but none of them had any permanent success. Three of these are mentioned in "Pharmacographia," one as early as 1535, which is considered rather doubtful; a second of the date of 1608, when Sir Matthew Lister brought seeds from Italy, and Parkinson raised plants from them. In 1742 Collinson was also stated to have raised plants from seed

obtained from Tartary. Besides these three instances, it may be added that plants were also raised about 1732 in Chelsea Physic Garden by the Curator, Isaac Rand.*

Dr. Hope, Professor of Botany at Edinburgh, described, in a communication to the Royal Society in 1765, the plants he had raised from Mounsey's seed in 1763 or 1764.

CONSERVANCY WORK IN SOUTH CHINA.

A report has been made of the proposed conservancy work in the middle and lower portions of the West River Valley in Kwangtung Province, South China. The delta around and below the city of Canton is a network of streams which are bank-high much of the time. Farther up the embankments have been eroded by flood and rain for many years, and in some parts demolished or given makeshift repairs. The houses in the villages are largely built on piles, yet in time of flood they are often overwhelmed. In the summers of both 1914 and 1915 this district was visited by floods of great severity, and the loss of life and property was tremendous.

According to a report sent to his Government by the officer in charge of the United States Commercial Attaché's office at Pekin, it was after the flood in 1914 that the first practical steps were taken to provide a remedy. The Board of Conservancy Works was appointed, and this body promptly arranged for an inspection and report by a representative of the Hwangpu Conservancy Board of Shanghai. The flood of 1915 gave valuable experience, and an exhaustive report on the subject has now been submitted. It suggests the possibilities of such thoroughgoing remedies as the reforestation of the watersheds and the diversion of portions of the rivercourse; but these are ruled out of practical consideration by the necessity of taking action which will produce results as soon as possible and by the limits of available funds.

For at least 800 years there has been a most complete system of dykes in this district, not only running along the banks of the rivers, but also following the innumerable creeks and penetrating the low country in all directions. The old dykes, as a rule, were well built of lasting material, and with proper maintenance should have averted the disasters of recent years. In modern times, however, there has been a lack of effective supervision by the higher authorities, or of public-spirited co-operation by the mass of the local population, and the present serious state of affairs has developed. Such repairs as have been executed were usually faulty.

The engineer who made the recent investigation and report believes that protection can be attained by confining the floods within the limit of the present dyke system, provided the barriers are partly reconstructed and properly maintained to a suitable elevation. It is believed, however, that it will be essential to put the final control in the hands of a single central supervising organisation acting on behalf of the Government.

The scheme of reconstruction recommended by the report embraces one system of primary and another of secondary dykes, with gates and sluiceways, so that the extent of the highest and most substantial embankments required will be brought to a minimum, and the annual upkeep reduced. The secondary dykes may be left to the villages to construct and maintain.

A more complete investigation of the present dyke districts is required, but a rough estimate of cost has been made on the basis of the data now accessible. For the improvements immediately contemplated, which comprise the reconstruction of the dykes on the West River between certain points, and of those on certain sections of the North River (above and below Samshui), it is calculated that 11,370,000 dollars Hong-Kong currency would be required, spread over six years' work. This represents only about one-third of the total work, however, and the cost of a complete project would be in the neighbourhood of 21,000,000 dollars. It is suggested that this might be raised in Kwangtung Province by the levy of an annual tax for fifteen years.

The expenditures would be made principally in the Province, and the money would come back to the taxpayers. It is roughly estimated that the effect of this tax would be to take from the farmers of the threatened districts 1·4 to 1·7 per cent. of their net profits for fifteen years, in order to bring the project to completion. If a portion of the burden was shifted to the shoulders of other than the agricultural classes, this figure would be reduced.

In order to make it possible to begin the work before this taxation scheme could be put in force, it is suggested that the funds necessary for the first year's work be raised by a foreign or domestic loan of 2,500,000 dollars.

ENGINEERING NOTES.

Possibilities of Air Flight.—A lecture on this topic was delivered lately by Brigadier-General Brancker to the members of the Aeronautical Society of Great Britain. He said that the way in which war had forced a higher standard on us was remarkable. Only two and a half years ago, a pilot who flew across country at 3,500 ft. and landed without breaking anything was considered to be quite useful. Now the expert pilot has to be prepared to fly at the greatest height his machine will reach, which is sometimes about 17,000 ft., has to dive and loop and side-

* "History of the Royal Society of Arts," p. 283.

slip to enable him to be an efficient fighter, and has to have considerable experience in photography from the air, in the observation of artillery fire, and the transmission of the results by wireless to the ground, and the use of the machine-gun. In addition, he must be an expert bomb dropper, which needs considerable practice and experience; and, finally, in bombing raids, long reconnaissances, and in fighting patrols, it is necessary for aeroplanes to fly in a fixed formation in numbers from two up to twenty, an operation demanding a great deal of skill and experience in the pilot.

Submarine Craft without Periscopes.—The *Rivista Marittima* is the authority for the following. U boats have been constructed without periscopes, and an alternative arrangement, having none of the disadvantages of visibility, has been adopted instead. The new system, which would appear to be in the experimental stage, consists of two lenses, one on either side of the submarine, which are used in conjunction with other lenses and reflectors. The drawback to the device is stated to be that the craft must be navigated nearer the surface than would be the case were a periscope fitted, but this drawback is claimed to be a lesser disadvantage than showing a periscope of the usual type. Another feature of the instrument is that a beam of light can be projected through the lens.

Industrial Potentialities in Hyderabad.—Mr. G. Wakefield, Director-General of Revenue, Hyderabad, has drawn attention to the commercial possibilities of the raw products of this State. One of the most important investigations was that of the mahua, or mhowra, tree, to which attention was drawn in the *Journal* of May 11th (page 472). This tree abounds in the forests and fields of Hyderabad, more especially in the districts of Nizamabad, Medak, and Asafabad. During the hot weather the flowers drop off the tree and are gathered and dried to the consistency of raisins. Hitherto they had been utilised for liquor only. About 25,000 tons, it is calculated, are gathered annually, of which about 10,000 tons are used for liquor and the balance is run to waste. It has been discovered that it is possible to make sugar, motor spirit, and several other valuable products out of mahua. It contains, in addition to sugar, acetic acid and acetone which is one of the principal ingredients of cordite. At present, for the manufacture of cordite in India, acetone is imported from Canada, where it is manufactured out of wood which contains only 1 per cent. of acetone. It is stated that the Government of India have purchased Rs. 70,000 worth of mahua from Hyderabad for use in their acetone factory at Nasic. Another fact which promises to be of great economic importance is that, with suitable additions, mahua spirit can be satisfactorily used as a substitute for petrol as a source of power in internal-combustion engines, particularly in motor-cars, and that several kinds of motor-cars have been successfully run on a spirit prepared from mahua at half the cost o petrol.

Longest Power-cable Span.—The demand for power in the Province of Quebec has risen to such heights (due to the manufacture of war munitions and various material not before produced in Canada) that the Shawinigan Water and Power Co. has been forced to undertake a record-breaking engineering feat—the spanning of the St. Lawrence River with a 100,000-volt transmission line, furnishing power and light to various towns. The construction of this transmission line entails the erection of two towers, which will support a 5,000-ft. span of three steel cables. This span is the longest of the kind known, exceeding the 4,427-ft. span across the Carquinez Straits in California. Towers will be necessary rising to the unusual height of 350 ft., the same elevation as the top of the Quebec Bridge. The height of the towers is fixed by the requirement of river navigation, the lowest point in the cable having to clear the water by 160 ft. minimum. The towers rest on concrete foundations located in the river about 500 ft. from each shore. These foundations consist of four circular concrete columns 11 ft. in diameter, extending to a depth of 40 ft. below the river bed and projecting 25 ft. above it, thus being partly submerged. The four piers are tied together above the water level by arched concrete structures forming a square. The concrete foundations will be protected against the action of ice by a low crib dam located about 100 ft. upstream, and arranged so that the ice will pile up and break in small pieces before it can reach the tower foundations. Into these four piers are to be anchored the four legs of the tower, which will be built of structural steel. At the top the towers widen out into a platform, on which are mounted the supports for the three cables, which are to be of plough steel. These cable supports are all on the same elevation and placed in such a position as to keep the cables 50 ft. apart, to prevent them from swinging together in the long span. The cables are not anchored at the supports, but are brought down on the back of the towers to an anchor in the ground at some distance behind the towers. The supports, however, are designed to allow a certain amount of movement to the cables, due to the expansion caused by changes in temperature. In order to use the cables as electric conductors to carry current at 100.000 volts, it will be necessary to insert insulators in them between the ground and the supports on

the towers. The magnitude of this problem is better understood when it is realised that these insulators are not only subjected to extreme electric tension, but also to a mechanical stress of above 150,000 lb. each. The arrangement of insulators must allow the replacement of any parts that may become damaged through electric failures without interfering with the mechanical safety of the span. The insulator group will consist of an elaborate arrangement of porcelain units of a new type subjected to pressure only, and held together by an iron frame. It is hoped to have the whole project completed by the end of the summer. This information has been extracted from the *Engineering News Record* of New York.

NOTES ON BOOKS.

THE WORK OF THE FOREST DEPARTMENT IN INDIA. Edited by R. S. Troup. Calcutta: Superintendent, Government Printing, India. 4 annas, or 5*d*.

The work of the Forest Department in India is comparatively little known. For the most part it is carried on in remote districts, so that few persons have an opportunity of becoming acquainted with it, and hitherto it has been difficult to obtain information as to its activities; for although such particulars might be available to those who knew where to look for them, they were scattered throughout the annual reports issued by Provincial Governments and in the various publications of the Forest Research Institute at Dehra Dun, and were not readily available to the general public.

The Royal Society of Arts may fairly claim some credit for the share it has taken in making known the work of this department, for a number of papers on various aspects of it have been read from time to time before the Indian Section by the late Sir Richard Temple, Sir William Schlich, Sir Saint-Hill Eardley-Wilmot, and (as recently as last April) by Mr. R. S. Pearson. These papers have been generally admitted to contain a great amount of most valuable information, but they do not, of course, do much to obviate the desirability of publishing in a single compendious handbook a general account of the work of the department.

The total forest area of British India is approximately 250,000 square miles, and, scattered as it is over the length and breadth of India, it comprises an infinite variety of types of vegetation. The problems of the Forest Department are therefore many and various. The handbook opens with a brief sketch of its history, from which it appears that forest administration in India was first set on a sound basis in 1855 by Lord Dalhousie, and by the appointment in the following year of Dr. Brandis as Superintendent of Forests in Pegu. The question of forest research had to wait for another half century, and it was not until the establishment of the Forest Research Institute at Dehra Dun in 1906, at the instance of Sir Saint-Hill Eardley-Wilmot, then Inspector-General of Forests, that this important branch of the work began to receive the attention it deserved. Additional buildings were completed in 1914, and the whole now forms a fine and imposing structure, as can be seen from the photograph which makes the frontispiece of the volume.

The section entitled "Forest Products" contains an account of the principal timber trees of India, and this is followed by a chapter on "Forest Industries," in which some description is given of pine-resin collection and distillation, the paper-pulp industry, match-making, the antiseptic treatment of timber, and the dry distillation of wood. A short section on "Financial Results" shows that the surplus has increased nearly tenfold during the last fifty years, and that it averaged £882,000 per annum during the last quinquennial period. The concluding section, on "Future Prospects and Requirements," pleads for a numerically adequate staff of scientifically-trained forest officers, and also of forest engineers, for the extension of roads and other export works to facilitate and cheapen extraction. "Given the necessary staff," concludes the book, "the organisation and development of the forests should in future proceed even more satisfactorily than it has done in the past, for the pioneer work is approaching completion, and the results of scientific research cannot fail to make themselves felt in an increasing degree. The present yield of the forests, as judged by the productive capacity of the soil, is a mere fraction of what it might be, and gives little idea of their potential value when fully brought under scientific management. India may therefore rest assured that in her vast forests she has an asset . . . . which holds out a bright promise for the future."

ELECTRICAL ENGINEERING PRACTICE. By J. W. Meares, F.R.A.S., M.I.E.E., assisted by R. E. Neale, B.Sc.(Lond.). Third Edition Revised and Enlarged. 25*s*. net.

Originally written for engineers in India, this book met with considerable success, which it well deserved, for it dealt with its subject in a simple and thoroughly practical manner, and contained a great deal of useful information and tables conveniently arranged for reference. When the first two editions had been exhausted, the author resolved to recast the book and to widen its scope, so that it now appeals to civil, mechanical, and electrical engineers in this country as well as in India.

The first part is elementary, and explains electrotechnical terms, the various kinds of electrical connections and systems of supply. Part II. deals in detail with installations in buildings and roads. The sections on electric lighting, heating, and cooking, and those on wiring methods and practice, will be found particularly useful to students.

Part III. is devoted to the subject of electric plant and supply, and contains chapters on electric driving and motors, generating plant, and the purchase of electrical energy, water-power, electric traction, electricity in mines, and the transmission of electric power. An entirely new chapter by Mr. R. E. Neale, on electric automobiles, and an excellent index add to the value of the volume, which is a very successful attempt (in the author's own words) "to fill the gap between the many excellent pocket-books of bare data and the highly technical works written for specialists in various branches of electrical engineering."

Higher Education and the War. By John Burnet, Dean of the Faculty of Arts in the University of St. Andrews. London: Macmillan & Co. 4*s.* 6*d.* net.

Dedicated to the memory of his Greek students who have fallen in the war, the aim of Mr. Burnet's stimulating volume we take to be such an examination and critical estimate of the ideals, methods, and results of Germany's scheme of higher education as shall help us, either by example or warning, in the settlement of some of our own educational problems, and more especially in the necessary post-war reconstruction of our higher educational facilities. "It is high time," as Mr. Burnet says, "for us to make up our minds what our attitude towards German education is to be."

He is here mainly concerned with Scottish conditions and Scottish schools and universities, the final chapters being a valuable contribution to some current problems and particular aspects of educational reform in Scotland; but there is a great deal that is of very much wider application, while the writer's own conception of a liberal education is adumbrated on every page. His is no mere plea for a classical as opposed to a scientific education, but for a training "in human excellence" preparatory to all special or vocational training, and therefore the same for a future mining engineer as for a Greek professor, and more or less the same for Scots or Prussians, or members of any other nationality, although the German doctrine of Kultur lays down otherwise. And here, perhaps, we may be allowed to say that Mr. Burnet's temperance and breadth of view are now happily characteristic of the first-class science man as well as of the first-class classic. The so-called war between classics and science is waged by the second-rate, and for the others is non-existent. The interests of both sides are, indeed the same.

Mr. Burnet's lucid exposition of the system of higher education prevalent in Germany since the beginning of the present century (already before the war the subject of acute controversy in Germany itself) ought to do much to remove the ignorance frequently characteristic of those who talk most glibly on the subject. It is as well, for instance, to remember that the curriculum of the Prussian *Gymnasia* is the product, not of the State doctrine of Kultur (which advocates a narrow nationalism and the revival of the cults of Odin and Thor), but of humanistic ideals inherited from the past, that it involves studying Latin for nine years and Greek for six, and that this was the education of the men who made the German Empire and of the present generation of scientific teachers and investigators in Germany. For it was not until the beginning of the twentieth century that the monopoly of preparing for the universities and consequently for the professions and the higher civil service, which had been enjoyed during the whole of the previous century by the classical schools or *Gymnasia*, was extended to two new types of school, the *Realgymnasium* (with Latin but no Greek) and the *Oberrealschule* (with neither Latin nor Greek); while even in these schools the education is of a wide, general character, in no sense vocational but based on the modern humanities. In no type of German Higher School is specialisation of any kind permitted, and this though the school-leaving age of the German *élite* is about two years higher than that of our English public schools, and three years higher than in Scotland—an important point to remember in all comparisons of national educational systems. It will be seen that it is rarely before the age of twenty, and generally considerably later, that the special training begins at the university, or other institution of university rank. It is not intended that we should adopt the German ideas in these matters—indeed, Mr. Burnet is concerned to point out the seamy side of such an educational edifice; but his chapters are, in effect, an adequate reply to the school of thought in this country which complains of our "neglect of science," finds the reason for our backwardness in the prominence given to classical studies in the curricula of our higher schools and colleges, and seeks a remedy in an earlier specialisation on what they suppose to be German lines.

On one incidental point our experience seems to be diametrically opposite to Mr. Burnet's. He writes: "The German manufacturer or industrial leader is, for reasons which will appear, a good deal better educated than ours usually are, and he, therefore, knows the value of the expert, and is prepared to pay him well and give him a free hand. The very same thing might be done in this country if there was the slightest desire to do it. There is already far more trained scientific ability in our universities than any one will make use of, and it could be increased if necessary." This may have been true, say, twenty years ago, but it may be doubted if to-day the captains of British industry are at all inferior in education to German manufacturers. It would be easy to mention among them men of the highest scientific attainments, who have moreover taught the Germans most of what they know in their particular branches of industry; and, besides these exceptional cases, there are now in this country hundreds of manufacturers who fully appreciate the value of the scientific expert, and are willing to pay him handsomely for his services. The Secretary of the Cambridge University

Appointments Board, who read a very illuminating paper on this subject before the Royal Society of Arts a few years ago, stated that he had more offers of good appointments in industrial firms for scientific men than he could fill. Cambridge is, of course, a shining example among University Appointments Boards, and Mr. H. A. Roberts is an enthusiast who has spared no pains to secure the sympathies of the manufacturers of this country and let them know how the laboratories of Cambridge can assist them.

But if on this one point Mr. Roberts's experience ran counter to Mr. Burnet's, on another he confirms Mr. Burnet's opinion in a striking manner. He showed very clearly that those who were most successful in industrial science or management were the men whose general education had been based on the widest and most liberal lines.

GENERAL NOTES.

Scientific Research in France. — The French Académie des Sciences en France have decided to establish a National Physical and Mechanical Laboratory for the purpose of scientific research, directed in a marked degree to the benefit and use of the industries. The laboratory will be controlled by a council, of which half the members will be nominated by the Academy, one-fourth by the State Department, and the remainder by the chief industrial associations. The executive control will be in the hands of a small technical committee. Existing laboratories engaged in similar work will be affiliated to the National Laboratory, and will work in close relationship to the latter. Substantial funds are to be provided for the working expenses of the laboratory and for the assistance of the affiliated institutions.

Asbestos in South Africa.—Asbestos has been found in such quantities in several parts of South Africa that a supply is already assured which is more than adequate to meet any expansion of the market for many years to come. Blue asbestos is found in the lower Griquatown beds, in the range known as the Asbestos Mountains, and has been opened up as far north as the border of the Bechuanaland Protectorate. There are several mines in full work; but elsewhere the recovery is obtained by surface quarrying. The Cape Asbestos Company, which was formed in 1893, controls the bulk of the production, and is the largest of the manufacturers of blue asbestos goods. According to *South Africa*, practically all the mining and extraction work is done by natives who work on contract or are paid by results. For textile purposes, about 25 per cent. of the fibre must be 1 in. and over. The average length of fibre, as mined in the Kuruman district, is above this standard, but that of the south appears to be lower. Best blue asbestos recently realised £45 per ton on the European market, while some special lots went as high as £65. Other current prices have been at from £16 to £18 for ¼-in. to ½-in. stuff, £25 to £27 for ½-in. to 1-in., and £30 to £35 for 1-in. and over. It averages all through £25 per ton landed in England from the Cape.

Chemical Industry of Japan.—One of the most remarkable features of the economic development of Japan, says the *British Trade Review*, is her extraordinary progress in the chemical industry. At the commencement of the war this industry was still in its infancy; yet to-day Japan is exporting chemical products for the supply of which she was but three years ago almost entirely dependent upon outside sources. Among many other things, Japan is making sulphate of ammonia from by-products of the gas and coke factories and from nitrogenous lime. The Tokyo Gas Company are making carbolic acid; and the Japan Dyestuff Company have laid plans for manufacturing it from benzol. The yearly production of sulphuric acid in Japan is little short of 750,000 tons; and it is intended to establish plant for the production of this acid by the contact process. As to the dyestuffs industry, the Japan Dyestuffs Manufacturing Company has been founded, and is backed by the Government. Before the war Japan imported from Germany coal-tar colours to the value of something approaching a million pounds sterling; and, although the Japanese industry is still in its infancy, it is quite clear that Japan does not intend to go on paying such a tribute to Germany.

Forestry in South Australia.—The annual report of the South Australian Woods and Forests Department states that the area of forest reserves and plantations within the State is 147,380 acres, and the area enclosed for planting and regeneration 20,897 acres. The largest plantations are at Bundaleer (7,376 acres) and Wirrabara (3,825 acres). The number of trees planted during the year was 436,652, of which 330,222 remain alive, or 75½ per cent. These consisted of six kinds of eucalyptus and as many varieties of pines. *Pinus insignis* has the leading place, with 157,419 surviving out of the year's planting; *Pinus maritima* comes next, with 57,070; and *Eucalyptus Creba* (narrow-leaved ironbark) third, with 44,566. There were during the year 2,370 applicants for trees, and the number of trees issued was 302,491. The number of trees remaining in the State nurseries on June 30th, 1916, both for distribution and for departmental planting, was 862,270. The statement of accounts shows that the legislative provision for the year amounted to £27,066, and the expenditure to £24,892. The income from timber and wattle bark, rents, etc., was £5,980. On the preparation of forest produce for sale, £2,180 was expended, and £3,672 received for fruit cases, telegraph poles, etc.

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FRIDAY, JULY 20, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday, the 16th inst., at their first meeting in the new session, the Council elected Mr. ALAN A. CAMPBELL SWINTON, F.R.S., Chairman for the ensuing year.

"OWEN JONES" PRIZES.

In consequence of the abandonment last year by the Board of Education of the National Competition of Students of Schools of Art, no prizes were offered under the Owen Jones Trust in 1916.

For the present year the Council, with the kind assistance of the Director of the Victoria and Albert Museum, were able to arrange an independent competition, and notice was sent out in November last stating that the usual six prizes would be offered under the usual conditions to students of Schools of Art. Each prize consists of a bound copy of Owen Jones's "Leading Principles in Composition of Ornament" and a Bronze Medal. The competition this year was limited to Designs for Textiles. The date for the receipt of competing designs was fixed for June 30th, 1917, and arrangements for their inspection were made at the Victoria and Albert Museum.

One hundred and twenty designs or works were sent in from twenty-two Schools of Art by seventy-three students, and these have been considered by the following judges, whose report has now been received and confirmed by the Council: Alan S. Cole, C.B., A. F. Kendrick, Professor W. R. Lethaby, Frank Warner, Arthur Wilcock, and Sir Henry Trueman Wood.

The judges report that the designs submitted show a high average of excellence, and that they could easily have awarded a larger number of prizes than those placed at their disposal, had a larger number been available. They have therefore, in addition to those designs which they recommend for prizes, mentioned a number of others which they consider worthy of commendation. Some of these are really up to the medal standard; others, while showing considerable artistic merit, are deficient in certain technical points necessary for rendering them suitable for adaptation to the various materials for which they are intended. The judges consider that the Society is to be congratulated both on the amount of work sent in under existing conditions by the various schools, and also on its high quality, and they hope that the arrangements adopted for the current year may be continued in future.

They think it desirable that greater stress should be laid by the students' teachers on the necessity for more attention to the technical details required in designs intended for reproduction by printing or in the loom. Very few of the designs sent in had appended to them any explanatory specification such as is usually required for the guidance of the technical craftsman who has to put the artist's drawing into the shape necessary for reproduction.

The following is a list of the recommendations of the judges, and the Council have awarded the prizes in accordance with them:—

RECOMMENDED FOR PRIZES.

Caudle, Hilda, L.C.C. Putney School of Art, Oxford Road, Putney, London, S.W.
Design for a Hand-woven Woollen Pile Carpet.

Cubley, Kathleen D. P., School of Art, Nicholson Institute, Leek, Staffordshire.
Design for printed Linen Door Curtain.

Hodgett, Ella, School of Art, Glossop, Derbyshire.
(a) Design for Altar-frontal Lace, to be executed in mercerised cotton, Peri Lusta, No. 150 (including instructions for working).
(b) Design for Super Frontal Lace.
(c) Hand-made Lace in filet-crochet worked in the cotton named above, with photograph showing the full Altar-frontal Lace consisting of three repeats.

Keeping, Gwendoline D., Municipal School of Art, Portsmouth.
Silk Damask Embroidered Mitre.

Kitchen, Wilfrid, School of Art, Macclesfield.
(*a*) Design for Woven Tapestry Hanging.
(*b*) Woven Silk Dress Material.

Smallwood, Robert, School of Art, Macclesfield.
Woven Silk Dress Material.

COMMENDED.

Clarke, Leonard, School of Art, Macclesfield.
Woven Silk Brocade.

Cubley, Kathleen D. P., School of Art, Nicholson Institute, Leek, Staffordshire.
(*a*) Design for printed Cotton for a Bed-hanging.
(*b*) Design for a Cushion Cover.

Froom, Dorothy, Hornsey School of Art, Crouch End Hill, London, N.
Design for Machine-printed Cretonne for Window Curtain.

Hildebrand, Charles H., L.C.C. Hammersmith School of Arts and Crafts, Lime Grove, Shepherd's Bush, W.
Machine-printed Cretonne for Curtains.

Leigh, Elsa Rose, Blackheath, Lee, Lewisham and Greenwich School of Arts and Crafts, Lee Road, Blackheath, London, S.E.
Furniture Silk and Working Drawing therefor.

MacEwan, Sheila, Hornsey School of Art, Crouch End Hill, London, N.
(*a*) Design for a Woven Woollen Tapestry for Curtains.
(*b*) Embroidered Handkerchief Sachet.

Pool, Ellen, School of Art, Technical College, Derby.
Cut Linen Table Cloth.

Savage, Aidan, School of Art, Technical School, Guildhall, Bath.
Design for Hand-woven Tapestry Panel.

Wooler, Elsie, Municipal School of Art, Cavendish Street, Manchester.
Design for a Printed Fabric.

In making the awards the Council desire to add an expression of their thanks to the judges for the trouble they have devoted to the work and for the promptitude with which the awards have been made.

They wish also to state their appreciation of the assistance which has been rendered to the Society by the Director of the Victoria and Albert Museum and his staff, especially at a time of great difficulty, when the available resources of the Museum are extremely limited in consequence of the transference now going on of the offices of the Board of Education to the buildings at South Kensington.

Arrangements have been made for the exhibition to the public of the competing designs and works. They will be on view from July 23rd to August 25th, from 10 a.m. to 6 p.m., in the Class Room, Department of Textiles (First Floor), Victoria and Albert Museum, South Kensington, S.W.

SHALL GREAT BRITAIN AND AMERICA ADOPT THE METRIC SYSTEM? *

By WALTER RENTON INGALLS,
President, Mining and Metallurgical Society of America; President, American Institute of Weights and Measures.

NOTE.—*I have sent this paper to the Institution of Mining and Metallurgy in the hope of opening the eyes of its members to a great danger with which it seems to me both Great Britain and the United States of America are threatened by the present strong metric propaganda. Although I have in my paper used American illustrations and references, and there are probably variations in British customs and practices, I feel sure that readers in Great Britain and the Colonies will find no difficulty in applying my argument to the things they know.*

The discussion of the metric system at the meeting of the institution on November 16th, 1916, prompts me to make a communication on this subject. In the United States there is a persistent and insidious effort by theorists to substitute the metric for the existing system of weights and measures. In order to combat this, the American Institute of Weights and Measures has lately been organised. The subject is of vastly greater importance than is commonly comprehended, and therefore an earnest propaganda is necessary in order to arouse the people of Great Britain, her Colonies, and the United States to the importance of preserving their interests.

Before entering upon any discussion of the metric system, let a sharp line be drawn between it and the decimal system. The advantages of the decimal system are so manifest in many cases that the prometric party is wont to cloud the issue by making it appear as if the metric system were the only decimal system. Really, there is the fundamental difference that the decimal system *per se* is merely arithmetic, while the metric system involves the basic units of weights and measures. Thus, for convenience, miners and smelters decimalise the ton, railway operators decimalise the mile, surveyors decimalise the foot, and machinists decimalise the inch. But the basic units remain unchanged.

* Paper read at a meeting of the Institution of Mining and Metallurgy (London), May 24th, 1917.

Another source of confusion will be dispelled if we can eradicate the chimerical idea of establishing uniformity, which in itself is alluring. But from a project that would manifestly put the weights and measures of the greatest industrial nations of the world at sixes and sevens it must be evident that the result would be more discord instead of more uniformity.

We find that the most ardent of the prometric party are those who have to deal with weights rather than with measures. The substitution of metric weights for English weights would create relatively little disturbance. Of course, the changing of all of our weighing scales would cost a huge sum, and the recalculation of schedules—such as railway rates—might come to something like the ransom of an empire; but after these were done, we might get on pretty well.

Personally, although I am strongly antimetric, I employ the metric system of weights in international statistics. Thus, in reporting the statistics of world's copper production, it is easier to convert the American figures into metric tons than it is to convert those of twenty other countries into pounds, although the American production may be 70 per cent. of the total. Moreover, in laboratory work, I use grammes and cubic centimetres, or kilogrammes and litres, both out of convenience and out of early habit in common with that of most chemists. By reason of such habit I visualise and sense the gramme better than I do the ounce; but when I pass to larger weights, the pound means more to me than does the kilogramme.

Similarly, out of habit I think of temperatures according to the Fahrenheit scale up to the boiling-point: there is then a range whereof I have no conception; but from red heat upwards I think in terms of the Centigrade scale. Of such mental habits and their bearing upon the substitution of the metric system, which I regard as a matter of major importance, I shall say more before concluding this contribution.

If weights and measures were employed merely as means of estimating and recording, there would be no great reasons why the metric system, or the Russian, should not be substituted for the English, save for the cost of providing the new instruments and the slight experience necessary to become familiar with them.

I happened to be operating a mine in Mexico in 1896 when the metric system was made compulsory there. Being law-abiding, we discarded the weights of the *arroba* and the measures of the *vara* and the *fanega* one evening, and began with the kilogramme and the metre the next morning. Not even were our simple *peones* and *pelados* flustered. What difference did it make to the carpenter whether he bought a kilogramme of nails or two pounds? Or to the woman whether she bought a metre of cotton cloth or a yard? Nor did it make any difference to the company whether it figured its ore shipments in tons of 2,000 lb. or of 1,000 kg.

It is such apparent simplicity of the change that is illusory and leads the metric advocates to proceed blithely with a programme into which they do not look deeply enough to see the consequences. They regard weights and measures simply as means of estimating and recording. They do not consider the *things* that are tied up with them, or the *knowledge* that is associated with them. By "things" I mean the standards that have become interwoven in our civilisation and industry, upon which indeed civilisation and industry are based.

Let me try to make my meaning clear by referring to land measure—a subject with which nearly everybody is familiar. In an unsurveyed country, like parts of Mexico, I can use a 100 m. tape as well as one of 100 ft., and can compute areas in square metres as well as in square feet. But suppose I am in the United States, where most of the land has already been surveyed in feet and miles and figured in acres and square miles, and I am compelled to divide metrically a Government quarter-section, my troubles would quickly begin. Anybody who has had to tie up with old surveys in New England, recorded in rods, chains, etc., knows what these would be.

Let us consider the conditions that have been established in the railway business of the United States. The tracks are marked with mile posts. The railway gauge is 4 ft. 8½ in. We might in course of time get in the habit of thinking of the latter as 1,435 mm., but manifestly it would never be convenient to refer to the mile posts as being 1·60935 km. apart, and either we should have to continue to think of miles, or else pull up the posts and replant them at kilometre intervals, which would be something of a job. Incidentally, our posting of highways would have to be revised, and the automobilist would mourn the day when metric legislation was enacted.

Returning to the railway business, it is well known that the passenger and freight schedules, which fill great volumes, are based on cents per mile and cents per 100 lb. The railways have complained of the great expense involved

in making alterations for the purposes of the Interstate-Commerce Commission. What would it be if the entire fabric had to be torn apart and rewoven in order to please the advocates of the metric system ?

A prometric scientist is reported to relate, with great gusto, the following story: "I needed to have turned a brass rod 20 mm. in diameter. The machinist told me he could not do it. I went home and converted the dimensions into decimals of an inch, after which I asked the machinist to turn a rod 0·7874 in. in diameter. He made no bones about it."

Why should he ? He would not undertake to turn the 20 mm. rod, for he had no millimetre scale. The dimension having been converted into decimals of an inch, he was able easily to take that with his calipers from his scale and gauge the rod when it had been turned sufficiently. But suppose this machinist was not doing merely piece-work, but was manufacturing on a large scale. His hundreds or thousands of workmen would neither have time to gauge diameters with calipers, nor would he trust them to do so. The measures would be done with the aid of standard gauges, conforming to the requirements of practice and convention.

These gauges are based on the inch. If the metric system were made compulsory, it is obvious that there would be but two alternatives, viz., to restamp the gauges with strange and unhandy figures, and wait until people became accustomed to them, as, for example, to ask for a 6·35 mm. rod when they wanted a ¼-in. rod ; or else to change the standards so as to make them conform to metric units. Either horn of the dilemma is bad, but the second one —the changing of gauges—would be calamitous. Some large American manufacturers have estimated that such a change would cost them individually from half a million to three-fourths of a million dollars.

So it is with all of our affairs. Our entire system of manufacturing, of building and of doing things is based on standard units, which cannot be changed except under conditions that would mean nothing less than calamity. Does anybody imagine that a 2×4-in. joist could be anything else but a 2×4, although it might be called a 50·8 × 101·6 mm. ; and after we were given specifications in metric measures, should we not have to translate them back into English measures, in order to make use of our tables of board measure for easy computation ?

Of course, we all know that a 2×4 is seldom of those exact dimensions, and we should probably call it a 50 × 100 mm. after we had learned the rules of the new game. But sometimes it is necessary to figure closely in connection with joists S4S, and then we know that the 2 × 4 is reduced to 1⅝ × 3⅝ in. How we should conveniently arrive at the exact dimensions of a nominal 50 × 100 mm. joist deponent saith not.

Consider what we do when we get a drawing of a French construction, let us say a metallurgical furnace, to build in this country. The first thing that has to be done is to redraw it, not for the reason that it is expressed in metric measurements, but for the reason that it calls for constituent parts of sizes that are not obtainable here. It is drawn in France so as to dovetail together all sorts of things that are standardised according to metric measures. In America we must use the things that we can get, and they are standardised according to inches.

Conversely, in drawing something of American practice to be constructed in France, we draw it in our own way and tell them to redraw. It would be easy enough to draw here with metric scales ; indeed, in my own practice I put a metric scale on each sheet destined for a metric country ; but engineering drawing is something different from the mere use of scales. It is the combination and representation of standard things, and we have to show our own, which we know—not the French, which we do not know— and let it be redrawn in France according to their standards that are nearest to ours. Any change of standards in either metric or non-metric countries is preposterous, unthinkable. We have all gone too far. Besides the colossal expense of substituting gauges, the result could not be anything but a mixture. The man who needed some ½-in. bolts for the repair of his automobile would not relish the information that they were no longer made, but that he could have 10 mm. or 15 mm. bolts.

But, say the metricists, "We do not intend to change the standards. We propose merely to call ½-in. bolts 12·7 mm. bolts, and similarly with other standard manufactures, and this is so that people in Spanish and Portuguese countries, where we hope to expand our export trade, will understand what we are talking about." There is no argument more childish than this. Why not, therefore, discard the use of the term bolts and substitute the Spanish equivalent ?

The manufacturer who is courting export trade in a Spanish country translates his catalogue into Spanish and converts his English measures into their metric equivalent.

The Argentine or Chileño has no difficulty in

being made to understand if the British or American manufacturer wants his business. If it be a question of competing with German manufacturers, they will make special sizes for that purpose, just as do foreign makers of automobile tyres who seek business in this country. Our tyre manufacturers would do the same if they wanted competitive foreign business. Nobody has had the effrontery to propose that the United States should discard its standard inch-sizes and substitute others conforming to foreign practice. The million automobilists would regard such a suggestion as a joke.

Illustrations of how we are tied to our standards may be multiplied endlessly to all intents and purposes, and this union is not merely one affecting the manufacturer, but also is it one that concerns all our accumulated knowledge. The engineer, for example, unless he be directly engaged in manufacturing, is not concerned with the matter of gauges, but his accumulated knowledge of physical constants, of the standards of material, of the units of work and of the cost of doing things constitute a large part of his professional capital, including what is stored in his mind and what is stored in the thousands of books in his library.

All of this is embodied in terms of English weights and measures. We have volumes of tables of figures devoted to the properties of structural steel. Similarly as to mechanics, hydraulics, surveying—in brief, all the branches of engineering. With the metric system these would be all but useless. Let us look at a relatively simple matter expressed metrically—viz., the computation of the products of combustion of coal, a problem that is common to the metallurgical engineer. I will translate from Toldt's "Regenerative-Gasöfen" on this subject:—

"1 kg. of air = 773·39 litres; 12·71 kg. = 9829·79 litres. According to the Gay-Lussac law, 1 cub. m. air weighs at t°C and at a pressure p kg. per sq. m.;

$$1 \text{ cub. m. air} = \frac{1 \cdot 252 \text{ p kg.}}{1 + a \text{ t.}}$$

"Assuming a mean temperature of 23·7° C. and a barometric pressure of 703 mm., the weight of a cub. m. of air is 1·104 kg., and 1 kg. of air = 905·8 litres.

"If 1 kg. of carbon be burned in atmospheric air to carbon dioxide, there will result 3·67 kg. CO_2 and 8·94 kg. N. The volumes will be 3·67 × (1000 ÷ 1·965) = 1867·663 litres of CO_2 and 8·94 × (1000 ÷ 1·2544) = 7126·913 litres of N, a total of 8994·576 litres of combustion products."

For the American and British engineer this might as well be written in Latin. Indeed, the compulsory adoption of the metric system would be no less preposterous than an edict that after a certain date all business in the United States—all buying and selling, all engineering, all figuring—would be illegal unless done in French. Either in French or in the metric system it would be possible to get along with the aid of the dictionary or conversion table and with constant use of pencil and a pad of paper. Imagine the motor-cycle policeman pausing in his chase of the automobile speeder to compute whether he were breaking the speed limit in kilometres per hour.

This brings us to the psychology of weights and measures in our daily life. I have referred previously to how some people think metrically of certain things and non-metrically of others. Neither the locomotive engineer nor the automobilist has to look at his speedometer to tell approximately how fast he is going in miles per hour. He knows. But he would have to perform a mental calculation to say it in kilometres.

The association of things of observation and experience is indeed the reason why certain of our old English measures, long since discarded generally, linger in special use. Thus the sailor speaks still of knots and fathoms, for he thinks in them. The hand as a measure of length has disappeared from usage except in indicating the stature of horses. Tell a horseman that a colt is 62 in. high or 5 ft. 2 in. high, and it means little or nothing to him. But say that it is 15½ hands high and he immediately visualises it, mentally comparing it with other colts of that known height.

Similarly does the chemist sense weights in grammes, while the apothecary does it in ounces. Such habits are not easily altered. Thus we find in France the use of ancient weights and measures, and the thinking in terms of them, lingering more than a century after the adoption of the metric system.

Having pointed out the objections to the compulsory adoption of the metric system, I hope effectively, even if but generally, let us consider the arguments that are offered in favour of it.

The prime argument is to have international uniformity. It is stated that a long list of the countries of the world have adopted the metric system, *only* the United States, Great Britain and her *Colonies*, and Russia (of the Indo-European nations) having failed to do so. I have italicised the words *only* and *Colonies*, for therein is concealed the speciousness of this argument. If with "Colonies" we equate

Canada, Australia, New Zealand, Tasmania and South Africa, we have a longer list of non-metric countries, and it comprises not only the most populous, but also the most industrial nations of the world.

A correct statement of this theorem would be: Considering the Indo-European race alone, there is a much larger population that does not use the metric system than does; and their nations are far superior in industrial development, measured by iron production, let us say, to all other nations combined. The foisting of the metric system upon them would be, therefore, like letting the tail wag the dog.

If uniformity be the objective, it would be better to institute a propaganda to induce Germany, France and the Latin countries to adopt the English system. In this connection it may be remarked that, although Russia has a system different from either, the fundamental Russian measure of length, which is the most important of all measures, is the foot, and the Russian foot is the same as the English.

Another argument on the ground of uniformity relates to the confusion existing in the English system owing to the different kinds of tons, pounds, gallons, etc. That there is such confusion, with its inherent dangers, is true; but it is also true that the confusion is much less now than it was twenty years ago, that it is bound to experience further reduction, and that it may be eliminated entirely in a way far easier than by the introduction of the metric system.

In Great Britain there is but one kind of ton, viz., that of 2,240 lb. In the United States, the English, or long, ton is employed to far less extent than formerly, and in the main we have standardised the ton of 2,000 lb. That we should have two pounds—the avoirdupois and the troy—is annoying, but the annoyance is now more academic than practical, for the troy pound is seldom used. Similarly have the differences among gallons, bushels, etc., lapsed in the main into innocuous desuetude.

But with respect to confusion, the skirts of the metric system are not clean. As a statistician of nearly thirty years' experience, I may say that I have fallen into more errors over the zentners and doppel-zentners of metric Germany, and the quintals and metric quintals of Chile, than I have over the pounds of England and America and the poods of Russia.

The third metric argument is the ease of the calculations, especially the correlation among measures of length, volume and weight. It may freely be admitted that there is some merit in this; but further on I hope to show that the English system is not quite helpless in this respect, and that the superior merit of the metric system is far short of being a determining factor, quite apart from its calamitous effect in overthrowing existing standards and upsetting the mode of thought of the people, which, of course, are the major considerations.

We come now to the alleged advantage of the metric system in promoting foreign trade—a matter that I have previously touched upon lightly in this paper. Listening to the metric advocates, one might imagine that Great Britain and the United States had no export trade with foreign countries before the war, and that the only way for them to compete with Germany after the war is to adopt the metric system because Germany will offer goods made according to it. We of the United States look upon Russia, China and South America as the regions of the world with which to build up great trade after the war. We had large trade with them before the war, and so did Great Britain, in spite of non-compliance with the metric system.

We hope and expect that after the war it will be greater. But in making it greater we are encouraged to think that the fundamental ideas are to offer them useful things, excellently made, through well-conducted agencies and by means of models and descriptions in their own languages, also dimensions with metric equivalents if they wish. And having interested them to the point of buying, we must extend to them the banking credits they need. and must pack the goods in such a way as will cause them to be delivered safely and will permit inland transportation by crude methods.

In many of these respects Germany formerly excelled us, largely owing to our indifference in this trade; but successful competition with her in the future is going to be based upon such major points as I have mentioned, and not upon the very minor one of making goods according to metric measurements. Does any one imagine that Russia is not going to buy McCormick reapers and Ford automobiles, that China is not going to buy American kerosene lamps and stoves, that South America is not going to buy Baldwin locomotives, because they are built to sizes of the inch and multiples thereof?

Ingersoll-Rand rock drills are sold in every part of the world, and will continue so to be sold for the reason that they are good drills and the company pursues good business methods.

including the maintenance of stores with repair parts at many centres. The Chilean, the Chinaman and everybody else is going to buy the rock-drill, the automobile and all other machines that he can most easily repair, original qualities being equal; and he is going to be swayed by such common-sense reasons, not by metric dimensions.

One other argument for the metric system is the alleged simplicity with which it can be acquired by schoolchildren. I do not believe that is so. Without having had any experience in school teaching, it has nevertheless been my good fortune to observe and supervise a number of children during their passage through the grammar school. In mental quality they have been better than the average. Without exception they have had difficulty with the metric system.

This has been partly due to the clumsy method of teaching it, the emphasis put upon learning a long list of strange names like the millilitre, centiare, decastere, etc., which, of course, are not used in real life even by metricists. But there seemed to be a deeper reason, which is not peculiar to the metric system, but pertains to any decimal system, viz., the difficulty of the youthful mind in grasping the idea of decimal fractions.

Vulgar fractions are comprehended more easily. This ought not to be so, but apparently it is. I think it arises from the natural tendency of all of us first to divide an integer into halves. Suppose one has a stick that he wants to divide into equal parts and has no scale. He gauges the length with a string and doubles it, getting halves; then he doubles it again and gets quarters. He cannot get thirds or fifths or tenths by any such simple method. The human predilection toward the binary division probably dates back to the time of the Cro-Magnon race and never will be eradicated.

In drawing this long paper to a close, let me revert to the philosophy of weights and measures. All of our systems, including the metric, are undergoing evolution, conforming to the requirements and practices of people, generally in the direction of simplicity. Most of the old English measures to which the metricists point with such scorn are obsolete. Nobody hears nowadays of the coomb, the pottle, the chaldron, the palm or the barleycorn. The perch, the puncheon, the span, the tierce and the toise are all but forgotten. Even the furlong, the gill and the rod are disappearing.

But so also with the metric system. The noble hierarchies of measures beginning with the millilitre and running up to the myriolitre, that running from the are to the hectare and the other from the stere to the decastere have been forgotten. In weights we talk of tons, kilogrammes, grammes and milligrammes; in long measure of kilometres, centimetres and millimetres; in square measure of hectares; in volume of cubic metres, litres and cubic centimetres, and we neither use nor think of much else.

Both in the use of the metric system and the English there are three well-defined tendencies. These are to discard unnecessary units and multiples, to employ measures of weight instead of those of volume wherever possible; and where not possible to substitute cubic measures for special forms. The first of these tendencies requires no elaboration. The second is due to the desire to obtain a degree of precision in matters of retail trade that otherwise is impossible. The housewife cannot buy a peck or a litre of potatoes and be sure of just what she is getting, but she can be when she buys in pounds or kilogrammes.

Sometimes the use of the old measures is retained merely as a manner of speaking. Thus the farmer talks about taking so many bushels of corn to the mill. What he really does is to take the corn there, weigh it in pounds, divide by 56 and call the quotient bushels. He does not measure the corn by volume at all. Some day he may forget to talk about bushels and will simply talk about pounds. Perhaps a reason why he continues to talk about bushels is that old records are expressed in such terms and he must continue to have such an expression for sake of comparison, which is only one other instance out of thousands of how in weights and measures the present is linked irrevocably with the past.

But there are many cases where weighing cannot be substituted for measuring. The vendor of gasoline, for example, would find it very difficult to weigh whenever a motorist called. We buy apples by the barrel and milk by the quart because those measures are the most convenient. Nevertheless, there is a constant tendency to substitute cubic measures for the old ones.

Thus our municipalities more and more sell us water by the cubic foot rather than by the gallon. This is because we visualise cubic measures better than anything else. The basis of all measures, using the term in distinction to weights, is the measure of length. Derived from it are the measures of area and of volume.

There are not many people, other than those who have to use it habitually, who have even an approximate conception of what is a bushel; but talk about the cubic foot and everybody can picture it, for everybody knows what a foot is. It is for the same reason that the metricist talks about cubic centimetres and not of millilitres; of cubic metres, not of steres.

I trust that I have made it clear that my argument against the metric system is not inspired by blind prejudice against an innovation. On the contrary, I remember the time when I was in favour of its adoption in the United States, and it was not until I had studied the matter more carefully that I changed my mind about that.

The metric system has many good points, chief of which is the correlation among measures of length, area, volume and weight; but if we remember that a cubic metre of water weighs a ton we find no difficulty also in bearing in mind that 1 cub. ft. of water weighs very close to 62·5 lb., or $\frac{5}{8}$ cwt., and that 32 cub. ft. of water weigh one ton of 2,000 lb.

In hydrometallurgical work we tend to reckon water and solutions by the ton rather than by the gallon or even the cubic foot, and some metallurgists have adopted the conventional fluid ton of 32 cub. ft. Whether this be a wise innovation or not I shall not venture to say. The important point is that in remembering the weight of a cubic foot of water, which is one of the constants that every engineer keeps in his mind, just as he does πr^2, it is just as easy to tie up with specific gravity in estimating the weight of materials as it is in the metric system.

It is indeed far more convenient to British and American engineers, who do not care to know the weight in kilogrammes of a cubic metre of lumber for the purpose of computation, but do want to know the weight of a cubic foot in pounds, inasmuch as railway schedules, the bearing power of soils, the strength of columns and all the engineering data that we possess are recorded in pounds.

Nor do I claim the English system to be perfect and consequently not to be touched. On the contrary, I have shown previously how it has experienced evolution and certainly it is capable of much further improvement, which undoubtedly will come about. What forms the improvements may take I shall not attempt to indicate more than briefly. It seems to me that we shall see a reduction in the number of units in common use, say to a list comprising the mile, the foot and the inch; the ton, the pound and the ounce; the acre.

For all other forms of square measure and for all forms of cubic measure, we may base on the foot. These few measures will be decimalised to a greater and still greater extent. The surveyor already uses the tape of 100 ft. and divides the feet into tenths. The machinist decimalises the inch. The architect reckons roofing, painting, etc., in "squares" of 100 sq. ft. The water and gas companies provide us with meters reading cubic feet and tenths thereof.

I hope to see the day when our legislatures will cease muddling over the size of barrel and let each industry adopt what suits it best, subject only to the requirement that its capacity in cubic feet and decimals thereof shall be marked upon it. We should like to see Great Britain adopt the ton of 2,000 lb. and decimalise her coinage on the basis of the pound sterling. Not to ask Great Britain alone to give way, let us adopt her gallon of 10 lb. of water, if gallon we must continue to use, as no doubt we shall have to for a long time yet. Let both Great Britain and the United States abolish the troy pound.

In conclusion, I desire to make it quite clear that my arguments in this paper are not directed against the metric system, but rather against the propaganda for the *compulsory* adoption of it. The metric system is already legal in the United States—has been for many years. Anybody is free to use it who wants to, and contracts expressed in its terms are perfectly good contracts. The aeronautical engineers dealing with a new art, which has no links with the past, could reasonably adopt the metric system and have done so.

The Nordberg Manufacturing Co. builds Diesel engines by this system, and the Ingersoll Rand Co. so builds Rateau turbines. But let it not be forgotten that even in Germany an inch-rod is still an inch-rod, no matter what it may be called in millimetres.

THE RESOURCES AND INDUSTRIES OF FORMOSA.*

The island of Formosa (Taiwan) lies between 21° 53′ and 25° 16′ N. and 120° 15′ and 122° E. It is about 100 miles from the Chinese coast, from which it is separated by the channel of Fokien. Its length is 255 miles, its average

* Most of the information in this article is taken from "The Statistical Summary of Taiwan" (published by the Government-General of Taiwan) and "The Climate, Typhoons, and Earthquakes of the Island of Formosa (Taiwan)" (Taihoku: Meteorological Observatory).

breadth 65 miles, and its area 13,330 square miles. Up to 1887 it was a dependency of the Chinese Province of Fokien; it was a separate province from 1887 to 1895, when it was ceded to Japan.

A mountain range extends throughout the length of the whole island. Several peaks are over 10,000 ft., one, the Niitaka, being 13,075 ft. above sea-level. On the plains are wide stretches of cultivated fields, while the mountains are covered with primeval forests, shielding natural resources of great value.

Climate.

The climate of Formosa is sub-tropical. The summer is long, lasting from April to October, and intensely hot; the winter, from November to March, is short, and no severe cold is known. The transition from the hot to the cold season is very sudden. Although the peaks of the high mountains are capped with snow, frost, except on very rare occasions, is unknown on the lower levels.

The mean temperature in April is 20° C. (68° F.). The hottest period is from June to September, when the mean monthly temperature ranges from 26° C. (79° F.) to 28° C. (82° F.).

During the winter months the north-east monsoon blows steadily, and this, together with the existence of the high mountain range traversing the whole length of the island, makes the weather of the extreme north a great contrast to that of the south. The monsoon, laden with moist vapour from the sea, comes in contact with the mountain range near Keelung, and condensation causes clouds and rain. Kastroryo, a few miles south of Keelung, with an annual rainfall of 7,338 mm., is probably the wettest place in the Far East. As one proceeds further south, there is less rain during this period—so much so that in the southern end of the island the want of it is sometimes felt.

From April to September, on the other hand, the south-west monsoon prevails in South Formosa, bringing abundant rain and frequent thunderstorms. There are thus two rainy seasons in the island, differing in period and region.

When the north-east monsoon is blowing, the seas near the island become very stormy; in particular, the violent winds and angry seas of the Formosan Channel are dreaded by sailors. Except when typhoons are prevalent, summer finds the sea calm.

Typhoons are the most destructive of the natural calamities that visit Formosa. Sometimes the wind assumes terrific force. In the typhoon that visited Formosa in August, 1911, the barometer at Kōshun fell to 702·9 mm. The velocity of the wind reached 49·2 metres per second, and at this point the cups of the anemometer were blown away, so that further observations were impossible; but the force of the wind was evidenced by the manner in which broken tiles were driven through wooden boards and trunks of trees. It is believed that its velocity reached 156 miles an hour. As a result of this storm, very great damage was inflicted in the southern part of the island: the total loss was returned as 305 dead, 378 wounded, 190 missing, and over 30,000 houses destroyed.

Earthquakes are also frequent, and, owing to the unsubstantial nature of the buildings in Formosa, they occasionally cause great damage to life and property.

Irrigation.

The principal crop of Formosa is rice, and consequently the country possesses a highly developed system of irrigation. The oldest of the reservoirs and canals date back two hundred years. Formerly the work of irrigation was left to private enterprise, but in 1901 the Government of Formosa issued Rules for Public Reservoirs and Canals, under which the Government assumed supervision over works intimately connected with the interest of the public in general. In 1911 the number of these works was 180, and they irrigated 158,679 ko.* Since then there has been a further extension of public irrigation constructed by the Government at its own expense and worked under its own immediate control. In addition to serving the primary purpose of irrigation, the water power at five different stations will be utilised for generating electricity to be conducted to important towns for lighting and supplying power. When the scheme is fully developed it is estimated that over 10,000 h.p. will be generated.

Forests.

Formosa is rich in forests. No accurate statistics of the area covered by them are available, but it has been estimated that the forests, wild lands, and river-beds traversing them cover about 2,900,000 ko.

Owing to the varying altitudes and meteorological conditions, the island contains immense varieties of vegetation, including tropical, sub-tropical, temperate, and even semi-arctic. Under Chinese rule, the forests in the civilised parts had been cleared, owing partly to

* 1 ko = 2·45 acres.

reclamation for agricultural purposes and partly to fires and indiscriminate felling for timber and fuel. Recently, however, reforestation has been encouraged, and great improvement is already noticeable. The land within the savage frontiers, except small patches cultivated by savage tribes, is nearly all covered with primeval forests, in which abound *hinoki* (ground cypresses), camphor trees, and *kashi* (pointed oaks). The Government have constructed a railway, 41 miles in length, in the famous Ari forest of Central Formosa.

Agriculture.

The soil and climate of the island are well fitted for agriculture. Rice, as has already been mentioned, is the principal crop, its value being 40 per cent. of the entire value of the island's agricultural products. The surplus, after supplying the needs of Formosa, is shipped to Japan, and in 1916 the value of the export amounted to nearly 7,000,000 yen.* Formerly Formosan rice was inferior in quality, but a good deal has been done to improve it in recent years.

Rye and barley are only grown to a very small extent. Many varieties of peas and beans are grown, notably the soya bean. The demand for the sweet potato has increased very largely, so that this crop now stands second in area of cultivation in the island. The pea-nut grows everywhere, and is often cultivated as an after-crop to the sugar cane or sweet potato. Tea is one of the principal mainstays of the island's trade. The area under it in 1916 was 38,770 ko, yielding 8,273,936 yen of manufactured leaves. Sugar has been grown for many centuries, but the industry was in a very primitive state, the variety of canes raised being of a poor kind, and the method of cultivation very careless. Great improvements have been carried out under the present Government, with the result that the sugar crop of 1911 was seven times that of 1903.

Indigo is raised as a rotation crop with sugar cane and upland rice. China grass fibre is shipped to China, and though owing to falling prices its cultivation was neglected for a time, there are now signs of its being more extensively grown. Jute and tobacco also figure among Formosan crops.

The island is rich in fruits, including oranges, persimmons, plums, peaches, bananas, pine-apples, pomegranates, coco-nuts, medlars, quinces, mangoes—all of which have a promising future as marketable fruits.

* 1 yen = 2s. approximately.

Manufactures.

Tea is mainly produced in the northern part of Formosa. It is shipped in a half-made state to Taihoku, Pankyo, and Suihenkyaku, where it is sorted and remanufactured into two grades, named respectively Oolong and Powchong. The former goes principally to America, the latter to Java and the Straits Settlements.

Sugar-making is the largest industry of the island, and its growth has been very rapid. Production prior to 1902 had never reached 1,000,000 piculs*; but by 1906 it had risen to 1,280,000 piculs, and by 1910 to 3,775,000 piculs. In 1916 all records were broken, the estimated output being 6,200,000 piculs of centrifugal sugar and 700,000 piculs of brown sugar.

The first charter for the erection of a modern sugar-mill in Formosa was granted in 1901, and there are at present fourteen companies owning thirty-seven crushing factories, with an aggregate crushing capacity of 27,240 tons per day of twenty-four hours. The total paid-up capital of these companies amounts to 56,175,000 yen. Although the export of sugar from the island to foreign countries was at first considered to be a matter of secondary importance, attention is now being turned to the export trade, the supply having overtaken the home demand.

A great deal of indigo dye is used locally, and although in 1911 there were 4,770 families producing 3,810 kin,† a large quantity had to be imported.

China grass, jute, and pine-apple are the principal fibre-producing crops. Hemp and pine-apple tissues are exported to China, and then reimported into the island in manufactured form. Since the establishment of the jute factory in Koroton in 1907, jute has been used for rice bags and sail-cloth, and there are prospects of an annual demand for four to five million bags for sugar, camphor, cement, salt, etc.

Bamboo grows freely all over the island, and a large variety of paper is made from it. Straw, tree pulp and sugar stalks are also available in large quantities, and are excellent paper-making materials. Some years ago a modern mill for the utilisation of bamboo pulp was established at Linnai, in Central Formosa. At first, owing to the high working expenses, the experiment was not successful, but when, in consequence of the war, the price of paper rose, the mill was reopened and is working now.

Vegetable oils produced from pea-nuts, sesame

* 1 picul = 133 lb. approximately.

† 1 kin = 1·3 lb.

and rape seeds are largely used for cooking and industrial purposes. There are over 500 oil manufactories, and further development in this direction seems probable.

A considerable number of "Rinto" hats are made, some finding their way abroad. These are made of screw-pine (*Pandanus*) fibre and resemble a Panama hat in shape. The annual production amounts to a million yen or more. There are good prospects for pine-apple canning and fruit-juice industries.

The manufactures of opium paste, salt, camphor and tobacco are Government monopolies. In the first named, Persian and Indian opium are chiefly used, though Turkish and Chinese are occasionally substituted. The amount of paste manufactured in 1916 was 26,355 kwan,* valued at 5,627,674 yen.

Formosa salt is exported to Japan, Chosen, Karafuto, the Russian Littoral, Hong-Kong and Manila. The total amount sold by the Monopoly Bureau in 1916 was about 141,826,998 kin.

Camphor oil is converted into camphor by a process of distillation. Formerly this work was conducted by private firms, but as there was much waste and inferiority of quality in the camphor produced, the Monopoly Bureau decided to undertake the work. In 1916 the Bureau sold 6,000,000 kin of camphor to Western countries, and 2,000,000 kin to refiners in Japan —a total of 8,000,000 kin, valued at 6,300,000 yen.

The output of leaf-tobacco is increasing, but the quality generally is not very high. The Monopoly Bureau have been for some time endeavouring to improve this, and they have also been experimenting with power plants for the preparation of cut tobacco.

* 1 kwan = 8·28 lb.

ITALIAN SOMALILAND.

The *International Review of Agricultural Economics* contains an interesting account of Italian Somaliland, from which the following particulars are taken:—

"The peninsula of Somaliland lies between longitudes 42° (River Ueb, tributary of the Juba) and 51° 16′ (Cape Gaurdafui), east of Greenwich, and latitudes 12° (Cape Alula) and 0° 8′ (Gulf of Juba) N.

"The territories in Somaliland included in the Italian possessions, protectorate or zone of influence extend as follows:—

"(*a*) From the Gulf of Aden and on the east coast of Somaliland, bordering the Indian Ocean, from Bender Ziade (49° long. east of Greenwich) to the Gulf of Juba (about 0° 15′ lat. S.) along a coastline of about 2,160 kilometres.*

"(*b*) In the interior, in the region comprised within the boundary line determined with respect to British Somaliland by the protocols between Great Britain and Italy concluded in Rome on 24 March and 15 April, 1891, and 5 May, 1914, and with respect to Ethiopia by the treaty of 16 May, 1908, which established the Italico-Ethiopian frontier in Somaliland.

"As regards the area and population of this vast region, the last *Annuario statistico italiano* stated that the interior of the Colony had an area of 357,000 square kilometres and a population of 300,000. . . .

"Somaliland is a fairly fertile country. The most varied crops do excellently (dura, maize, beans, sesamum, greens of every kind, india-rubber, cotton, agave sisalana, palms, cocoa, papaw-trees, kapok, forage grasses, etc.), and seeds sprout within a short time even on the most desert land, while so long as they are watered by rain or irrigation the plants rise to heights unknown elsewhere—a proof of the fertility of this soil, which is formed of the alluvial deposits of centuries modified by meteorological agents, and provides potent elements of fecundity which few districts of East Africa can match.

"Among crops which can give a large return cotton certainly stands first, both for quality and quantity. Dr. Onor, Agricultural Consultant for Italian Somaliland, expressed himself as follows with regard to the cotton obtained at Caitoi on the Scebeli† :—

"'The quantity of fibre obtained at Caitoi was considerable in relation to the cultivated area. From about 5,800 square metres‡ of cultivated land 459 kilogrammes§ of fibre were obtained, which gives the high average yield of 790 kilogrammes a hectare.|| The cotton was shelled with rudimentary native appliances exactly like those I have seen in Apulia, which leave a small portion of the seed mixed with the fibre, but not enough to cause any important variation in the figures I have given. The yield would have been even superior if parasites had not done damage after the first harvests. It is my conviction that in favourable years the harvest might surpass the rosiest expectations and surpass by much the average of 900 kilogrammes a hectare, which is that of Egypt's maximum yield. This is easy to understand, because in Benadir the vegetation is not impeded by a fall in the temperature at the time of harvest. Certainly the American average of

* 1 kilometre = 1093·633 yards.

† Statement No. 4 in *Relazione sulla Somalia Italiana per gli anni* 1911 *e* 1912. *Documenti.* Rome, Tipografia Camera Deputati, 1912.

‡ 1 square metre = 1·196 square yards.

§ 1 kilogramme = 2·2 lb.

|| 1 hectare = 2·47 acres.

200 kilogrammes a hectare and the Egyptian average of 400 kilogrammes would normally be surpassed.'

"These remarks refer to Afifi cotton. The following information was given, in an interview reported in the English papers, by Mr. Henry Powell, Director of British Agriculture in the Colony of British East Africa, a most competent authority. In speaking of the experiments conducted by the State at Alessandra on the Juba he made the following statements, equally applicable to agriculture in the adjacent Italian Colony:—

"'A plot of about one acre was planted with Abassi cotton and completely irrigated, with the object of showing the capacity of the soil in the most favourable conditions and with the best possible agriculture. Over one half of the land the furrows were traced at intervals of 34 in. and the seed was sown on 6 May at intervals of 18 in. On the other half the furrows were made at intervals of 30 in. and the seed distributed at intervals of 34 in. on the same day. The development of the plant was marvellous on both areas. Mr. Filleul, Vice-Commissioner of the province, found, however, that the closer plants did best, owing to their greater density, which allowed the bushes to resist the strong winds prevalent in Alessandra. Three thousand pounds of seeded cotton were harvested in this irrigated area (Alessandra), producing 1,000 lb. of fibre. In view of the purposes which it can serve, the value of the fibre can be placed as low as 6*d.* a pound, at which rate the sale will produce nearly £30.' Mr. Powell says that 'existing conditions in Alessandra are, however, extraordinary.' He recommends the place as the site of experimental farms, thus completely recognising its great fertility. 'From the analysis of a specimen of the earth made at the Imperial Institute it appears that the soil is perfect. In such a soil crops would rapidly flourish, helped by the fertilising waters of the Juba. Thus the large yield of cotton is comprehensible, and it is to the interest of capital and of the colonists of all nations who ought to come to the country—and be induced to come to it—to give to Jubaland that energetic development for which she offers so rich a soil and such abundant waters.' Such are the uniform conclusions to which agricultural experts in the British and the Italian Colonies have come as to cotton-growing, which is the true and the most productive form of agriculture in this land.

"Other crops might be no less rich and promising if this extraordinary fertility of the soil were supported by an essential condition—irrigation.

"Although native crops (dura, maize, sesamum* beans) can be grown in good years and bad years, with periods of abundance and periods of scarcity, by means of the rain and the small canals which the natives assiduously make along the rivers to receive the waters in times of flood, crops having a large industrial yield—such as cotton, indiarubber, tobacco, etc.—cannot run the risk of more or less rainy seasons. The rivers—the true irrigating channels—are natural reservoirs against the variable rainfall, and since the rivers are full precisely in the rainy season, a system of mechanical hydraulics is necessary, especially for raising and barricading the waters, in order better to regulate and utilise the rivers. The value of the Colony cannot be realised by its agricultural and industrial development apart from the factor indispensable to such development, namely, irrigation by canals, dikes and mechanical means. But, on the other hand, it is certain that the great productiveness can meet the expense these works would entail and richly compensate for it. It is also necessary to recollect that the River Scebeli provides sufficiently favourable conditions for uncostly hydraulic works which will regulate and dam its course, at least in the region of High Goscia, which is among the most fertile in Somaliland.

"The extent of land available for cultivation by white colonists is very great if the sparse population and the slightness of native agriculture be considered, but is limited not by area, but by the volume of the waters of the rivers in the season of scarcity. This limitation can be partly corrected by artificial dikes and reservoirs, and also by the results which may be yielded by the investigations—as yet incomplete—into the nature of crops and the sowing seasons, and which will show how to derive the greatest possible profit from the rainfall, the irrigation from the rivers being regarded as a supplementary resource. It is clear that to reach this result it will be necessary to confront the vast and complex problem of a general utilisation of the rivers, which now follow their unregulated courses, wandering through the plains as chance has willed it. . . .

"As regards natural vegetation, subdivided into forest and undergrowth, we will say briefly that the only forest properly so-called extends along the Juba for a distance of about a hundred kilometres and has an average depth of no more than 200 metres.* It is clear, therefore, that forests of forest trees in Somaliland are very unimportant. Beyond this stretch along the Juba and others like it but of less area, found at several points along the Scebeli, there is in Benadir a monotonous arboraceous vegetation, little developed and very thorny, chiefly bushes. On the whole it is the opinion of competent experts that the resources to be derived from the spontaneous vegetation of Italian Somaliland are very limited.

* Half a hectare (1·235 acres) planted with sesamum on the farm of Genale produced a crop sold at Merca for 200 rupees = £13 6*s.* 3*d.*

* 1 metre = 1·094 yards.

"Somaliland is a country well suited to pasturage. There is excellent pastureland, all on the plain and of very great extent. Since the dry season lasts only for about four months in the year, it is clear that the raising of useful live stock is the most important feature in the country's economy.

"The capital in live stock is, indeed, considerable. Statistics which the Colonial Government has been enabled by the district authorities to prepare show that in Southern Somaliland alone there are about 764,000 head of cattle, 305,000 camels and 216,000 sheep. Thus the quantity of live stock is indubitably such as to justify the care given by the Colonial Government to this form of wealth, and any initiative which might lead to its exploitation in the interest of the home country. In Somaliland Italy has an enormous breeding park which might, with suitable care and improvement, ensure to her an important annual contribution in the form of excellent butcher's meat. But in order that the value of this reserve may be realised its quality must be improved, by protecting it from certain constant and powerful agents of depreciation, and it must be more actively commercialised.

"As regards cattle alone the average weight a head of the fully grown animals is more than 400 kilogrammes, and the market price was, before the war, 10, 16, and 24 Maria Theresa thalers* a head, according to whether the purchase was made in the interior or on the coast. That is to say, in the least favourable case, allowing for only 50 per cent. of the living gross weight and for the maximum price, meat was sold on the coast for 27 liras a quintal,† without taking into account the skin, the price of which is being lowered. Indisputably these prices justify a confidence that there could be trade in meat with Somaliland, and that, in view of the prices on European markets, it could be remunerative in spite of costs of transport and the increase in cost price which would be caused by a demand and by other circumstances peculiar to commerce.

"Before the war slightly more than 3,000 head of cattle and about 8,000 sheep were annually exported from Benadir. The skins of the exported oxen, which may furnish another element of profit to be taken into account, weighed 405,000 kilogrammes. Probably a considerable number of them emanated from the districts of Abyssinia which lie below Lugli. Such weight corresponds to 58,000 head of live stock, if seven kilogrammes be taken to be the average weight of a dried skin." ‡

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* Maria Theresa thaler = nearly 2s. at par.

† 1 quintal = 220 lb.

‡ For further details on this subject see *Atti del Secondo Congresso degli Italiani all' Estero*, and especially 8th session, Theme II., *Dell' allevamento del bestiame in Somalia e del suo trasporto in Italia*, Dr. Ferdinando Martoglio, Vol. I. Part III pp. 1715–1753.

OBITUARY.

PROFESSOR O. KRISTIAN B. BIRKELAND.—Professor O. K. B. Birkeland, of Christiania, who was elected an Honorary Corresponding Fellow of the Royal Society of Arts in 1909, died at Tokyo on June 18th. He was perhaps best known as the co-inventor with Mr. Sam Eyde of the Birkeland-Eyde direct process for the manufacture of calcium nitrate by the extraction of nitrogen from the atmosphere. A full account of this was given in a paper read before the Society by Mr. Eyde on May 26th, 1909. The first experimental station was established at Frognerkilens in 1903, but owing to the difficulties of obtaining sufficient power there, the station was moved, and finally a factory was built at Notodden, which is still the headquarters of the industry. So rapid was the growth of the business that the company controlling the Birkeland-Eyde patents had 200,000 h.p. at work in 1912, and there has been further development since that date. Besides this process, there were several other successful patents in which Professor Birkeland was interested, and he had, moreover, done much original work in the field of pure science. He was Professor of Physics in the University of Christiania, and he devoted much time to the study of the magnetic disturbances in the Arctic regions. He considered that the ultimate cause of the aurora borealis was the cathode rays emanating from the sun. The wealth which he had acquired enabled him to experiment and arrange for solar and magnetic observations on a large scale. He was mainly responsible for the institution of special magnetic observatories in Arctic regions in 1900, in 1902–3, and again during the last few years. His work, "The Norwegian Aurora Polaris Expedition, 1902–3," contains a great deal of information as to the simultaneous progress of magnetic disturbances at different parts of the earth. Since 1910 he had passed much of his time abroad, in Africa and elsewhere, for observational purposes, and no doubt he had visited Japan with the object of prosecuting his researches.

PROFESSOR JAMES HECTOR BARNES, B.Sc.—Professor James Hector Barnes died at Pusa from enteric fever on June 2nd, in his fortieth year. He received his scientific training at the University of Birmingham, where he took the degree of B.Sc. In 1905 he became an assistant analyst in the Worcester County Laboratory, and in the following year he returned to Birmingham as assistant to Professor Percy Frankland, with whom he remained for about seven months. He then joined the Indian Agricultural Service as Agricultural Chemist to the Punjab Government and Professor of Chemistry in the College of Agriculture, Lyallpur, and in 1908 he was appointed Principal

of the College. A few months ago he became Imperial Agricultural Chemist of Pusa, the senior chemical appointment in the Indian Agricultural Service.

He was elected a Fellow of the Royal Society of Arts in 1916.

GENERAL NOTES.

Medical Conditions in India.—In the House of Commons on July 11th, Mr. King asked Mr. Austen Chamberlain, Secretary of State for India, whether he was aware that Sir Malcolm Morris went out to India in 1913 to investigate the medical conditions there; whether he visited the military hospitals and reported on them; whether he made any such representations as to warn the India Office or the Government of India of the deficiencies now revealed; and whether any steps were taken as a result of Sir Malcolm Morris's visit. Mr. Chamberlain: "Yes, sir. It was my good fortune to preside at a meeting of the Royal Society of Arts on March 27th last, when a paper on medical research work in India, prepared by Sir Pardey Lukis, Director-General of the Indian Medical Service, was read by Sir Havelock Charles, medical adviser to the Secretary of State and Dean of the London School of Tropical Medicine. In the discussion which followed Sir Malcolm Morris gave a brief but very interesting account of his visit to India and of the admirable scientific work which was being done there, and spoke of the great opportunities which India offered for students and of the great results which might follow from their labours. I believe that Sir Malcolm Morris while in India was afforded facilities for seeing whatever he wished; but as far as I know, he made no report to the Government of India, and certainly he made none to the India Office."

Kauri-gum Oil in New Zealand.—According to a report by the United States Consul-General at Auckland, a company has been organised to extract kauri-gum oil from peat taken from the swamps in the northern part of the North Island, where kauri gum has been mined for many years. Some years ago a company was formed for this purpose, and machinery installed. The plant was worked for some time, but not with favourable results, since the methods adopted and the machinery installed were not well suited for the work. Eventually the undertaking was abandoned for a time. It is claimed that the peat yields 20 to 30 gallons per ton of kauri-gum oil, of which about 25 per cent. resembles petrol. The remainder contains some twenty-eight different kinds of heavy oils, some of which make exceptionally good varnishing material. It is stated that in the northern part of North Island there exist extensive beds containing much fine kauri gum particles, and rich in materials producing this kauri-gum oil, as well as kauri gum that may be extracted from the deposits.

Platinum Substitutes.—In consequence of the war, the price of certain metals has been so advanced that the question of obtaining substitutes will become a question of high importance for many consuming industries. Thus we may see, says *Page's Engineering Weekly*, aluminium tried in the place of tin for plate purposes, and tungsten alloys competing extensively in what has been hitherto the preserve of platinum. This movement is, of course, irrespective of temporary substitutions, which have been enforced by lack of some particular substance either to the Allies or to the enemy during the war—Germany has, no doubt, had very extensive experience of such deprivation—which may possibly in some cases permit of eventual economic substitution, as, for instance, in the range of material available for aluminium manufacture. The question of substitution will, however, be mainly governed by the two conditions outlined above: excess production on the one hand, and insufficiency for the world's requirements on the other. Of all substances platinum is perhaps the one which most attracts attention. The present price of platinum, approximately £15 per ounce, makes it the target of the metallurgist. The United States Bureau of Standards has recently reported favourably on a gold-palladium alloy, designed as a substitute for platinum, for chemical crucibles. It is said to compare very favourably in resistance to the action of chemical reagents with the standard platinum crucible, though inferior to it for use with fused alkali pyrosulphate; but for most purposes it is successful, and its cheaper cost naturally makes it preferred for such uses. In scientific work also there is reason to suppose that tungsten alloys and probably other combinations may, in one department or another, prove adequate substitutes.

Zinc Resources of the United States.—The United States Geological Society has published a report on the zinc resources of each zinc-producing State in the United States, accompanied by a map showing the location of zinc-producing districts, zinc smelters, electrolytic zinc plants, and zinc oxide plants, and by tables showing the production for several years. An interesting tabulation gives the individual output of the principal zinc-producing districts. Brief summaries are also given of the zinc resources and zinc-smelting capacity of the foreign countries whose product now competes with that of the United States. Copies of the report may be obtained on application to the United States Geological Survey, Washington, D.C.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section was held on Monday, the 23rd inst. Present :—

Sir William Duke, K.C.S.I., K.C.I.E. (Chairman of the Committee); Sir Charles H. Armstrong; Sir Arundel T. Arundel, K.C.S.I.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.; Thomas Jewell Bennett, C.I.E.; Sir M. M. Bhownaggree, K.C.I.E.; William Coldstream, B.A., I.C.S. (retired); Sir John Jardine, Bt., K.C.I.E. M.P.; Sir Henry Ledgard; Sir Frederic S. P. Lely, K.C.I.E, C.S.I.; Sir Charles Campbell McLeod; Colonel Sir Arthur Henry McMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I.; Sir Frederick Alexander Robertson, LL.D.; with G. K. Menzies, M.A. (Assistant Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Section).

THE COMMAND OF WOOL.

Tables estimating the world's wool production by territories are not actually the most helpful means of ascertaining the relative importance of the wools of the British Empire. This is not merely because all such tables are approximations, but because they treat of wool as a homogeneous article, whereas some forms of it are so distinct from others as to deserve separation. The gain, therefore, in the attempt to bring the whole world into review is offset by some loss of accuracy and definition. There is, however, a demand for estimates as comprehensive as conditions will allow, and that published for 1915 by the National Association of Wool Manufacturers (U.S.A.) may stand as an example :—

	Lb.
NORTH AMERICA :	
United States	288,777,000
British North America	11,210,000
Mexico	7,000,000
Total North America	306,987,000
Central America and West Indies.	750,000
SOUTH AMERICA :	
Argentina	264,500,000
Brazil	35,000,000
Chile	17,000,000
Peru	9,420,707
Falkland Islands	3,200,000
Uruguay	143,293,000
All other	5,000,000
Total South America	477,413,707
EUROPE :	
Austria-Hungary	41,600,000
France	75,000,000
Greece	16,000,000
Germany	25,600,000
Italy	21,500,000
Portugal	10,000,000
Russia-in-Europe	320,000,000
Spain	52,000,000
Turkey and Balkan States	90,500,000
United Kingdom	121,200,043
All other	30,000,000
Total Europe	803,400,043
ASIA :	
British India	60,000,000
China	50,000,000
Persia	12,146,000
Russia-in-Asia	60,000,000
Turkey-in-Asia	90,000,000
All other	1,000,000
Total Asia	273,146,000
AFRICA :	
Algeria	33,184,000
British Africa	157,761,470
Tunis	3,735,000
All other	13,000,000
	207,680,470
OCEANIA :	
Australia and Tasmania	569,775,000
New Zealand	197,266,914
	767,041,914
All other	100,000
Total Oceania	767,141,914
Total World	2,836,519,000

The totals relate to all kinds of wool and some forms of hair, without respect of their quality or condition, and a simple process of extraction from the tables would suggest that the British

countries furnish 1,140,300,000 lb., or 40 per cent. of the whole. The version does not overstate the case, and it is enough to show the Empire is rich in a material that is not less essential for purposes of war than the oil, rubber and metals which are more often mentioned. Upon the other hand, it shows the Central Empires poor with their small home clip of little more than half that of the United Kingdom, and with such additional supplies as can be got from the Balkans or Bagdad.

Possession gives power whether in peace or war, and the British ownership of so large a proportion of the wool supply is emphatically not an advantage to be neglected. In a limited way, wool is already being made to pay some of the expenses of the war, for since its assumption of control the State does not sell wool for civil purposes without exacting a certain profit. The idea of wool as a public asset has to this extent been accepted, and some fuller notion of the power represented by the fact of ownership can be gained by considering facts in more detail. It should be understood, in the first place, that no industrial country is self-supplying with the material. Be the home resources what they may, each manufacturing country has to import supplies, and for practical purposes these countries may be regarded as those of Europe and North America.

Upon the evidence of the table already given, the wools from Australasia and the Cape constitute, approximately, one-third of the gross volume, and they are the most desirable of the whole. These are the classes known as the Colonial wools, although they do not comprise all that come from British Dominions. They are merino and crossbred wool, the staple material for fine and medium goods, and they represent upon last year's valuation a sum of £65,300,000. The average annual consumption of them in Europe and North America, condensed from the admirable tables of Messrs. Schwartze, Buchanan and Co., may be thus expressed :—

	English.	Continental.	American.	Total consumption. (Thousand bales.)
AVERAGE TEN YEARS, 1904–13:	893·8	1428·4	106·1	2428·3 (Average value, £37,626,300.)
AVERAGE THREE YEARS, 1914–16:	1425	724·6	480	2629·6 (Average value, £54,761,000.)

The statistics of consumption pay no regard to takings by local or Japanese mills, and they show that for a decade before the war 36·8 per cent. of the consumption was British. Since 1913 the exceptionally large proportion of 54·1 per cent. has been consumed in this kingdom, various alternative markets having of course been closed and a new complexion having been put upon British industry by the war. What is particularly to be noted is that very nearly two-thirds of this choice Colonial wool has been consumed in Continental and American industry. This particular supply, which has been estimated roughly at one-third of the world's resources, has been as perfectly indispensable to the foreign mills as to British ones. The only large alternative source of materials at all comparable is South American. Argentina and Uruguay supply crossbred and merino which do not in fact replace Colonial exactly in point of quality, and are manifestly far inferior in point of quantity. The American estimate assigns to these two countries a production of 407,800,000 lb., which for rough purposes can be called one-seventh of the gross supply against the Colonial one-third.

From the River Plate the average exports to Europe and North America have been :—

AVERAGE:	Bales.	Equivalent in Colonial bales.
Ten years, 1904–13	487,800	(1,469,400)
Three years, 1914–16	376,000	(1,128,000)

The statement includes the British consumption, which cannot with certainty be separately stated, and if there be added the quantities from Punta Arenas and the Falkland Islands, a nearly complete account is rendered of the Colonial wools and their nearest types. The imports into Europe and North America have been :—

	Bales.
AVERAGE TEN YEARS, 1904–13:	
Punta Arenas	48,100
Falkland Islands	7,600
AVERAGE THREE YEARS, 1914–16:	
Punta Arenas	55,000
Falkland Islands	7,900

Concentrating attention upon Colonial and South American wools alone, it appears that in the ten years before the war 61·6 per cent. of the kinds of wool of supreme interest to manufacturers came from countries within the British Empire. These are wools of greater or less fineness of quality, distinctively suitable for human clothing; they are forthcoming in large and uniform quantities, and by comparison with them nearly all other sorts can be classed as miscellaneous. They are the *grandes laines*, the international wool contributed by the pastoral to the industrial countries, and the commerce in them virtually composes the

wool market. Not that there is no international movement of coarse wools like the East Indian, which serve chiefly for carpet and blanket-making, or the Chinese, North African, Persian, Turkish; and not that there is no movement of wools produced in the countries where the wool-working industries are carried on. Dealings are transacted in special classes of wool of all origins, and under stress of war wools of odd kinds are employed for purposes for which they would not be selected in time of peace. There are, however, no substitutes for the Colonial and South American clips, and command of them gives a leverage upon the whole wool-consuming world.

The natural advantage of the British ownership of the wool supply has not been too widely realised in the past, and opinions will not be uniform on the correct policy to adopt in the future. Only in so far as the position is special need the possibilities concern us here. It can be shown with no difficulty that wool-growing upon the grand scale does demand exceptional conditions of climate, soil and vegetation, which can certainly not be satisfied at will. Wool production can be encouraged and stimulated; but the experience of the United States, for example, shows how hard it is to increase the growing of wool rather than of alternative forms of agricultural produce. These may be arguments in favour of such exploitation of an effective monopoly as would enable revenue to be raised from it. Hitherto, of course, wool has been accessible to all-comers upon equal terms, and its producers have had the benefit of an unrestricted competition for their produce. Attempts to tax the export to one country or another might naturally lead to attempts to grow wool elsewhere, and, as there are areas as yet unoccupied upon which sheep might thrive, it is possible that the efforts would meet with some success. The probability of aiding competition might at least be a consideration in fixing the rate of any proposed taxation.

As wool is a material capable of being stored indefinitely without undergoing marked deterioration, it must always be difficult to prevent its eventual passage into unfriendly hands, and if it were possible to restrict the destination of raw wool effectually, it could not be easy to limit that of wool in any of its manufactured forms. The point that wool is a war material will be remembered in future, and it is just as well to reflect that so is woollen fibre other than in its virgin form. The Central Empires are able after three years of blockade to clothe their troops largely by means of the systematic collection of woollen rags. Old garments shredded to fibre again, reinforced if possible with new wool, and extenuated with cotton and twisted paper yarns, provide the new uniforms of the German reserves. In our own country there is a systematic return of worn clothing from the battlefield for remanufacture, and there has been notice at least of a proposed house-to-house canvass for woollen rags. The possibilities of living off the rag supply are governed in the first place by the thoroughness of the collection. Granting that the fibre has not been too enfeebled in the course of wear, the rags of woollens themselves made from rags can be turned into cloth again. In every successive incarnation the stuff is poorer, and wear and disintegration are accompanied by progressive loss, but it need not be impossible at a pinch to make wool serve three times over.

The best Army uniforms for ordinary purposes are those made with the fleeces of the meat-sellers' Canterbury lamb. The animal is a merino crossed with an English strain, and its pelt having been soaked in lime water is "sliped" for the removal of the loosened wool. The material is used by the British Army as far as the supplies will go, but wools British and Irish, Australasian and South American, far finer and also far coarser than this ideal and normally cheap New Zealand article, are employed with an unprecedented catholicity. Subject to the maintenance of minimum standards of strength, rag wool may be blended with the stronger virgin material, and it has been proved that upon a pressing emergency there are few sorts of wool that cannot be made to serve military uses. Wool is nearer to being all one in war than peace; but with the restoration of peace there will infallibly be a return to the old practice of using fine wools for fine purposes and strong wools for coarser cloths; and in face of the long hungering of the world's markets, the British Imperial wool supply will be of an extraordinary importance for a series of years.

THE PULP AND PAPER INDUSTRY IN CANADA.*

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Wood pulp may be divided into two classes —mechanical pulp and chemical pulp—and the latter may in turn be subdivided into sulphite,

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soda and sulphate pulps. Mechanical pulp, or, as it is more commonly known, groundwood pulp, is manufactured in far greater quantities than any of the others; in fact, the amount of groundwood produced exceeds that of all the other pulps put together.

The following table shows the relative amounts of the various pulps produced in Canada in 1915, and gives some idea of their comparative importance :—

Kind of Pulp.	Per cent. distribution.
Groundwood pulp	52·9
Sulphite pulp	33·5
Sulphate pulp	13·1
Soda pulp	0·5

At the present time there are about eighty mills in Canada engaged in the manufacture of pulp or paper or both. The mills vary in size from small units producing 15 tons of groundwood per day to enormous plants turning out 200 tons of newsprint per day, and manufacturing the groundwood and sulphite pulp which goes to make up the paper.

Barking and Cleaning the Wood.

Whether pulp is made by mechanical or chemical processes the preliminary treatment of the wood is the same. The woods most used in Canada for the production of pulp are spruce and balsam. Spruce is by far the most important wood, as it produces a better pulp than can be obtained from other species. The pulp produced from spruce is of a better colour, stronger, and lends itself to the production of a fine sheet of paper better than any other species with the possible exception of poplar, which, for some grades of paper—*i.e.* book—is of as great importance as spruce. Spruce was used in the production of 50 per cent. of the pulp made in Canada in 1915; balsam fir was used to the extent of 33 per cent.; while the remaining 17 per cent. was made up of hemlock, jack pine, and poplar.

The wood arrives at the mill in the form of logs and bolts, the logs varying in length from 16 ft. up, while the bolts are generally 4 ft. in length. The diameter of the logs and bolts varies, but most mills accept nothing under 4 in. in diameter at the small end. A large proportion of the wood is peeled at the lumbering operations, and in the case of unpeeled wood which has been river-driven a great deal of the bark has been removed by the action of the water and through friction during the driving. However, some wood is received with the bark still on, and this must be removed by the plant at the mill. The logs are cut into 2-ft. or 4-ft. lengths by slasher saws, and the bark is removed either by a rotary barker or by a barking drum. The former consists of a heavy circular iron disc placed vertically in a strong casing and revolving at a speed of from 700–850 revolutions per minute. The disc is provided with several knives projecting from the surface. The log is fed across the face of the disc, and at the same time is pressed against it and rotated in such a way that the knives slice the bark from the wood. Barking, or "rossing" as the process is called, removes a considerable amount of wood with the bark. The amount of bark on a log amounts to about 10 per cent. by weight, while in the barking process about 20 per cent. of the weight of the log is removed; this means that in addition to the bark about 10 per cent. of wood is being taken from the stick. In order to reduce this loss barking drums are used in many plants.

There are two types of drums in use at the present time, the closed drum and open drum. The closed drum consists of an iron cylinder closed at both ends, with a door on the side of the cylinder for charging in the wood. The drum rotates on hollow trunnions, holds about two cords of wood per charge, and has a capacity of from twenty-four to forty-eight cords per twenty-four hours, depending upon whether the wood has been brought to the plant in cars with the bark practically intact and in a dry condition, or whether it has been river-driven and the bark softened and partially removed. The wood is placed in the drum, the cover bolted down, the drum revolved, and water is run in at one trunnion and taken out at the other. The tumbling of the wood and the rubbing action between the sticks removes the bark, which is carried out of the drum by the water flowing through the trunnions. The open-type drums are made up of angle irons with openings between and are open at both ends. The drums are generally placed at a slight angle and rotate in a trough of water. The wood enters continuously at one end, passes through the drum where the rolling and tumbling action removes the bark, and is discharged at the other end. The bark falls through the openings between the angle irons to the bottom of the tank, where it is removed either by hand or by a conveyer system. In most mills the rossing refuse is burned under the boilers, 3 lb. of refuse being equivalent to about 1 lb. of coal. As the bark from the rotary barkers is in a fairly dry state it can be used at once as a fuel, but the refuse from the barking drums must be dried before it can be used. Some mills dump the bark outside in large piles to dry, but this method requires considerable time and handling. The most efficient way of treating the refuse is to pass it through press rolls which squeeze out the moisture to a content of about 50 per cent., whereupon the material can be used directly in the boilers. The following figures give an idea of the saving made by using drum barkers :—

	Lb. air-dry pulp from 1 cord wood.
Rotary barkers	1,700
Barking drum	1,950

Mechanical or Groundwood Pulp.

Groundwood pulp is produced by the grinding action of sandstone on wood. The stone tears the fibres from the wood and isolates them more or less completely. The grindstones are made from a fairly coarse sandstone; most of them are imported from England, although a few are produced in Canada. Of late artificial grindstones have come into use, but have not yet been perfected to the point where they are able to supplant the natural stones. The stones, usually 54 in. in diameter with a 27-in. face, are ordinarily mounted vertically on a horizontal shaft and enclosed in a circular cast-iron casing provided with pockets in which the 2-ft. lengths of rossed wood are placed. The wood is forced against the stone by pistons which are operated by hydraulic pressure, the pressure used varying as a rule from 30 lb. to 50 lb. per square inch, and the stone travels at a circumferential speed of 2,500 ft. to 3,500 ft. per minute. The grinders are driven either by waterwheels, individual water turbines or electric motors, the latter being particularly good practice in mills situated near large hydro-electric developments where power is cheap. Each grinder is equipped with either three or four pockets about 24 in. long and 12 in. wide, in which the wood is placed with the grain parallel to the longitudinal axis of the stone. The horse-power required for each stone is 300 to 500, and 40 to 70 horse-power per twenty-four hours is required to produce a ton of pulp.

During the grinding process water is sprayed on the surface of the stone to keep the wood from burning and to carry away the fibres which adhere to the stone. In order to vary the nature of the pulp produced the amount of water used is varied. If a large amount of water is used "cold ground" pulp is obtained, while with a limited amount of water the grinding temperature rises to as high as 150° F., and "hot ground" pulp is produced. "Cold ground" pulp is very even-fibred and fine, and can be used in fairly good grades of wood-pulp paper, while "hot ground" pulp is coarse, uneven, contains long fibres and is used in cheaper grades of paper, such as newsprint, wrappings, etc. The "hot ground" pulp works particularly well on fast news machines, as the water drains from it quickly, making it possible to operate the machines at high speed.

The pulp goes from the grindstone to a tank below the grinders, and from here to a coarse screen where all the coarse splinters and unground pieces of wood are removed. After diluting with water it then passes to the fine screens, which may be of the flat or the rotary type. The flat screen consists of a long shallow box with the bottom made up of perforated bronze plates. The perforations are of the nature of long slits about ·012 in. wide through which the pulp must pass. Below these plates is a diaphragm which moves rapidly up and down, keeping the pulp in a state of agitation and causing a slight suction. The pulp mixed with a large amount of water flows into the flat screen, the water and fine material passing through the screen while the coarser pulp moves on to the end of the screen, where it flows into another flat screen with coarser perforations. In this way the pulp is sorted into coarse and fine grades. The centrifugal screens are somewhat more complicated, but act on the same principle of passing the fine pulp mixed with water through small openings, leaving the coarse material behind.

The screened pulp then passes to machines called wet machines for partially removing the water. The diluted mixture is pumped continuously into a vat about 6 ft. wide and 8 ft. long and 5 ft. deep, in which a hollow bronze cylinder about 3 ft. in diameter and 6 ft. long covered with 60-mesh brass wire rotates. The pulp is deposited on the wire while the water passes into the cylinder, and from there is led outside the vat. A small roll called a couch-roll is in contact with the top of the revolving cylinders, and an endless felt passes between the couch-roll and the cylinder. The sheet of pulp upon the cylinder is picked up by the felt, carried between press rolls over a suction box, and finally wound up on a large wooden roll until of sufficient thickness. At the proper time it is removed from this roll either by hand or automatically.

The pulp sheets as they come from the wet machine contain about 65 to 70 per cent. moisture. When the pulp is to be shipped from the mill it is often pressed in a hydraulic press to reduce the water content to about 50 per cent. Another type of apparatus nearly always employed in mills where the pulp is to be used at once is the "thickener," "feltless wet machine" or "decker," as it is variously called. This machine consists of the vat and cylinder of the wet machine, but the pulp, instead of being picked up by a felt, is scraped off the cylinder by means of a board extending along the length of the cylinder, and in contact with its surface. By this means the pulp is thickened so that the mixture contains about 95 per cent. water as against 99–99·5 per cent. in the original mixture. Wet pulp, *i.e.* pulp containing 50 to 65 per cent. water, is always sold on the "air dry" basis. "Air dry" pulp refers to pulp containing 10 per cent. moisture.

Chemical Pulp.

In the manufacture of chemical pulp chemicals are used to isolate the fibres. These chemicals dissolve out the lignin and other substances which are intimately mixed with the fibres and leave a nearly pure cellulose as a residue. Chemical pulp is produced either by the sulphite, soda or sulphate process.

SULPHITE PROCESS.

This process may be conveniently divided into four steps, namely, preparation of the cooking liquor, preparation of the wood, digestion of the wood with chemicals and washing, screening and removing water from the pulp.

Preparation of Cooking Liquor.

The raw materials used in the preparation of the cooking liquor are sulphur or pyrites and dolomitic limestone or a mixture of burnt lime and magnesia.

The preparation of the cooking liquor may be subdivided into the burning of the sulphur or pyrites to form sulphur dioxide, the preparation of the lime, the absorption of the sulphur dioxide by lime water or limestone to form cooking liquor, and the recovery of the sulphur dioxide from the digestion process.

In the production of sulphur dioxide either sulphur or iron pyrites may be used. When sulphur is used three types of burners may be employed, namely, flat burners, rotary burners, and upright retort burners. The flat burner consists of a shallow covered pan with a counter-balanced sliding door in front, into which the sulphur is shovelled, and through which the air for combustion enters. To start the burner a small wood fire is built in the pan, after which sulphur is shovelled in. After the sulphur has become thoroughly ignited, it maintains the heat for its own combustion, and it is then only necessary to keep the burner supplied with sulphur and to regulate the air supply. Sulphur contains considerable impurities, and these float on the surface of the molten sulphur and have a tendency to deaden the fire. Although various stirring mechanisms have been devised to agitate the sulphur, this difficulty has never been thoroughly overcome, and for this reason, and for the fact that the flat burner exposes only a relatively small surface to the action of combustion, this type of burner is being supplanted by other and more efficient types. The rotary burner consists of a long cylinder with cone-shaped ends mounted horizontally on steel tires riveted to the cylinder shell and resting on bearing wheels. The bearing wheels are made to revolve, and the weight of the cylinder thus concentrated on the revolving bearing wheels causes the cylinder to rotate. Either dry or molten sulphur is fed into one end of the burner, and the gas is taken out at the other. As the cylinder rotates, the molten sulphur clings to the sides and drips back to the bottom of the cylinder, causing excellent agitation and exposing a large surface to combustion. At certain points on the burner openings are placed, which furnish air and enable the supply to be accurately regulated. These burners are very efficient, and furnish a supply of very rich gas. One of the latest forms of burner is the upright retort burner. It consists of an upright cylindrical shell lined with firebrick, and fitted inside with a series of shelves one above the other. At the top of the burner is a large closed melting pot for melting the sulphur. The dry sulphur is either shovelled by hand or carried by a conveyor into the melting pot, where it is melted by the heat of the burning sulphur inside the burner, and from here flows to the upper shelf of the burner, where it ignites. The shelves are provided with openings arranged in such a manner that the sulphur overflows from one shelf, falls through an opening, works its way across the next shelf, and presses through an opening to the next shelf. In this way the sulphur passes back and forth through the burner, exposing a large surface to the oxidising action of the air until it reaches the bottom compartment, where the ashes and other impurities collect. This burner is provided with openings for the proper regulation of the air, and a very rich gas is obtained. It is claimed for this burner that it embodies all the advantageous features of the rotary burner, with the additional advantages that it occupies less space, requires no power to operate, and is very easily cleaned.

The sulphur dioxide gas passes from the burner to a combustion chamber, where the hot gas is intimately mixed with the air, and where any unburned sulphur which is carried over is oxidised. It is then conducted to coolers, which are made up of 8-in. to 12-in. lead pipes, connected in series and placed in a shallow tank of running water. The gases are cooled on the counter-current principle—that is, the gas travels in the pipe in one direction and the water travels in the pipe in the opposite direction, so that the coldest water is in contact with the gas as it leaves the cooler, and the water which has taken up heat in its passage through the cooler is in contact with the hot gas as it enters the cooler; this ensures that the gas leaves the cooler at the lowest possible temperature. The gas then passes from the cooler to the acid system.

There are two types of acid systems—the limestone system and the milk-of-lime system. Both are in use in this country, but until very recently the milk-of-lime system has found most favour; however, within the past three or four years the limestone system has become very popular. The limestone system is used almost entirely in European countries.

In the latter system, either pure limestone ($Ca\,CO_3$) or dolomite limestone ($Ca\,CO_3$, $Mg\,CO_3$) in high towers, or a number of low towers or chambers, is used. The high towers are from 100 to 125 ft. in height, about 10 ft. in diameter, are made of concrete or wood, and are ordinarily lined with wood or acid-resisting brick. The towers are filled with pieces of limestone varying from 3 to 6 in. in diameter, and resting on timbers at the bottom. Water is sprayed over the limestone at the top of the tower, and trickles downward over the stone while the sulphur dioxide gas enters the bottom of the tower and

passes upward. The ascending stream of sulphur dioxide gas meets the water as it passes downward over the stone and is dissolved, forming a weak solution of sulphurous acid, which in turn attacks the limestone forming the soluble compound bisulphite. The bisulphite solution runs into a chamber at the bottom of the tower, and is pumped to storage tanks.

In the case of low towers, four or more are connected together and operated in pairs. The towers are from 35 to 50 ft. in height, and are filled with limestone as in the case of the high towers. The towers are connected by means of earthenware pipes, and the gas passes up through the first tower through the earthenware pipe to the bottom of the second tower, and then up through this tower. Water is sprayed over the top of the limestone in the second tower, dissolving the sulphur dioxide and reacting with the limestone forming calcium bisulphite, and this is pumped from the bottom of the second tower to the top of the first, where it trickles down through the stone, becoming stronger as it nears the bottom of the tower. From the bottom of the first tower it is pumped to storage tanks. Here, as in the case of cooling the gases, the counter-current principle is used: weak gas is in contact with the weak liquor in the second tower, while strong gas is in contact with the strong liquor in the first tower. In case more than two short towers are used, the principle is the same, *i.e.* the strong gas enters the first and the water enters the last tower, and they travel in opposite directions. When high towers are used, the natural draught is sufficient to move the gases, but with short towers it is necessary to employ fans or pumps to conduct the gases from tower to tower.

In the chamber system there are two long rectangular chambers, connected together and each containing a number of compartments, connected alternately at the top and bottom. The compartments are filled with limestone, and water is pumped to the top of the last compartment, where it trickles down over the stone, meeting the gases which are passing in the opposite direction. From the bottom of the last compartment the weak acid is pumped to the top of the next, and so on through the system, becoming stronger and stronger as it proceeds. It finally empties into the first compartment, which contains only acid, through which the strong sulphur dioxide gas bubbles on its way to the limestone compartments. From here the acid is pumped to storage tanks.

In the milk-of-lime system, burned dolomite lime (Ca O, Mg O) is slaked with a large amount of water to form milk of lime, and sulphur dioxide is passed through it to form calcium and magnesium bisulphites. There are several types of apparatus in use for carrying out this reaction, and they can all be classed under two main heads — the intermittent or "dump" system, and the continuous system. The Stebbins System is a good example of the "dump" system, while the Barker System illustrates the continuous system.

The Stebbins System consists of two acid tanks and two milk-of-lime tanks, equipped with agitators, baffle plates and cooling pipes. When the system is in operation the first tank of the series contains weak acid, the next tank is filled with milk of lime, while the two milk-of-lime tanks serve simply as storage tanks. The sulphur dioxide coming from the gas cooler is drawn by means of a suction pump to the bottom of the first tank, up through the weak acid to the bottom of the next tank, up through the milk of lime and out of the system. Thus the weak acid in the first tank becomes strengthened, and the milk of lime in the second tank is converted to weak acid. As soon as the acid in the first tank is of sufficient strength, it is pumped to storage tanks, and the weak acid in the second tank is led into the first tank to take the place of the strong acid, while the weak acid in the second tank is replaced by milk of lime from the storage tanks. As can be readily seen, this process is intermittent and is called a dump system, because the strong acid tank, *i.e.* the first tank, has to be emptied at the end of each operation.

The Barker System consists of a high tank with perforated partitions, and overflow pipes from one partition to the next. The milk of lime flows in at the top of the tank, and gas enters at the bottom; a suction pump connected to the top of the tank draws the sulphur dioxide gas up through the tank and leads off the unabsorbed gases. The rate of flow of the lime water and the degree of vacuum produced by the suction pump are so regulated that the gas passes up through the perforations in the partitions, while the lime water overflows through the overflow pipes, and the acid comes from the bottom of the tank at the proper strength. Some of the advantages of this system are that it occupies a comparatively small space and does not require constant attention. Since the lime water flows without interruption into the top of the tank and comes out at the bottom as acid the system is known as a continuous system.

In the digestion process, which will be described later, a certain amount of sulphur dioxide gas and acid has to be relieved from the digester from time to time, and to operate efficiently the gas and acid have to be recovered and utilised. This is accomplished by conducting the gas through coolers to a storage tank containing the cooking acid, or "reclaimed acid," as it is called, where the gas is absorbed by the acid, causing the latter to become stronger. The acid or "liquor" which comes from the digester is passed through coolers and run into storage tanks containing the acid made in the acid

system. This mixture of acid from the acid system and liquor from the digester is known as "storage acid." The "storage acid" is pumped to other storage tanks, and the sulphur dioxide gas from the digesters is passed into it as described above, forming "reclaimed acid," which is then ready for use in digesting the wood to form pulp. The "reclaimed acid" varies in density from 55° to 6·5° Be, and the sulphur dioxide content varies from 3·5 to 6 per cent., of which 25 to 30 per cent. is present as calcium bisulphite and 70 to 75 per cent. as free sulphurous acid.

Preparation of the Wood.

After the bark has been removed from the wood, as described under "Barking and Cleaning the Wood," the bolts are conveyed to the chippers. A chipper consists of a heavy cast-iron disc, from 47 in. to 88 in. in diameter, with a steel rim shrunk on. The disc is mounted vertically on a horizontal shaft, and is encased in a strong housing. The chipping of the wood is done with two or more knives placed radially on the face of the disc and projecting from the disc. The wood, in the shape of short bolts, is fed to the chipper through a spout, which holds the end of the stick against the face of the disc at an angle of 45°. The size of the chip produced may be altered by changing the set of the knives and the speed of the chipper. Depending upon the cooking process to be used, the chips vary in size from ⅝ in. to 1⅛ in. square, but the average chip used in the sulphite process is between ⅝ in. and ⅞ in. square, and ⅛ in. and ¼ in. thick. The 88-in. chippers operate at a speed of 200 revolutions per minute, and have a capacity of 10 cords of wood per hour, and can be driven with a 100 to 125 h.p. motor. When the chippers are working properly, they should deliver chips 60 to 70 per cent. of which are of the size desired, with not over 3 per cent. of sawdust.

From the chippers the chips are conveyed to the chip screens, where the sawdust and large chips are screened out. Two types of chips screens, flat shaking screens and rotary screens, are in general use, and they are often operated together. Either wire screen or perforated metal plates are used in constructing the screens. The coarse screens have openings with a diameter about ½ in. larger than the length of the chip desired, while the fine screens have a mesh of about ⅜ in. Shaking screens consist of two shallow boxes placed one above the other, the bottoms of which are made up of wire screen or perforated metal; the screens are hung in such a manner that they may be shaken back and forth by an eccentric. The chips are fed to the top screen, which has the larger perforations, and which holds back large chips and slivers, and allows the smaller chips and sawdust to pass through. The finer material falls to the second screen, which has a fine mesh which retains the chips, allowing the sawdust to pass through. In addition, the chips are generally passed through a conical-shaped rotary screen of fine mesh for the complete removal of the sawdust, and from here are carried by a large conveyor belt to the chip bins above the digesters. The coarse chips from the upper shaker screen are led by a spout to chip crushers, which reduce them to small chips. There are several types of crushers: one type consists of an iron disc fitted with projecting steel pins; the disc is encased by a housing and rows of pins are attached to the casing, the pins on the disc rotating between them; the chips are broken up between the stationary and moving pins. Another type consists of movable hammers rotating about a shaft; the chips are fed into the crusher and are broken up by the blows of the hammers. After passing through the crushers the chips are rescreened. The sawdust from the screens, together with the refuse from the barkers, is burned under the boilers.

Digestion of the Wood.

In order to separate the wood into fibres suitable for paper-making purposes, it is cooked or digested with the cooking acid at high temperatures until the intercellular matter such as lignin is dissolved out, and the fibres isolated in the form of fairly pure cellulose. The cooking is carried out in large steel digesters capable of producing 8 to 12 tons of pulp per cook. The digesters in general use are upright, stationary cylindrical tanks with cone-shaped tops and bottoms. They vary in height from 40 to 50 ft., are from 12 to 18 ft. in diameter, and are constructed of 1¼-in. butt welded boiler plate. A large manhole for charging is placed at the top of the digester, while the bottom cone is connected to a large pipe for emptying the pulp. Since the acid used for digesting the pulp attacks iron and steel, it is necessary to line the digester with some resistant material in order to protect it. When the sulphite process first came into use lead linings were employed; but these were very expensive and the repair costs were excessive, so that at the present time they have practically gone out of existence and brick linings are used. The general practice is to lay down a first course of ordinary red brick, filling in behind the brick with Portland cement and ground quartz, then to lay a second course of acid-resisting flint brick with a grouting between the two courses consisting of Portland cement and quartz. The joints of the first course of brick are made with a binder consisting of cement and quartz, while those of the second course are made with a mixture of litharge, glycerine, and quartz in order to make them acid-resisting. All digester valves and other fittings are made of acid-resisting bronze. Two outlets are provided for relieving gas and acid, one situated on the side of the digester a little distance from the top, and the other in the

manhole cover. Inlet pipes from steam are provided at the bottom, and the acid is generally pumped in at the bottom although it is sometimes admitted at the top.

Cooking conditions vary greatly at different mills and depend upon the kind of wood used, the grade of pulp produced, the strength of the acid, and other factors. On the whole, however, the general procedure is as follows: The digester is first filled with chips and acid, the digester cover put in place and bolted down, and the relief gas connections made. Steam is then admitted to the digester through the steam connections at the bottom. After one hour the digestion pressure will be around 20 lb., and at the end of the second hour in the neighbourhood of 40 lb., after which the pressure rises at the rate of about 5 lb. per hour until a pressure of 75 lb. and a temperature of 165° C. or 330° F. is reached. At intervals during the cook it is necessary to let out some of the liquor which has accumulated owing to the condensation of steam, and to relieve off some of the sulphur dioxide gas liberated in the process of cooking. This relieving of the acid and gas is necessary in order to bring the digester contents to the proper temperature, since, if the pressure in the digester was made up of hydrostatic pressure due to the liquor present and gas pressure due to the sulphur dioxide gas liberated, no steam could enter, and the contents would never be brought to the proper temperature. The time of cooking varies from six to twelve hours. At the end of the cook the pressure is relieved down to 50 lb., and sometimes as low as 30 lb., the valve in the pipe at the bottom of the digester is opened and the digester content is blown out; this is called "blowing" the digester. The above method of cooking, in which the steam is admitted directly into the digester and in which the cooking time is from seven to twelve hours, is known as the direct or "quick cook."

Another method is used in which copper coils are placed on the inside walls of the digester. Steam enters these coils and heats the contents of the digester, bringing them up to 55 lb. or 60 lb., as compared with 75 lb. in the quick cook process. The cooking time for this process is eighteen to thirty-five hours, and the process is known as the "slow cook" or Mitscherlich process. The pulp produced by this method of cooking is superior to that of the quick cook in strength, pliability, and appearance.

Pulp from either the quick cook or Mitscherlich process is blown from the digester into a closed wooden tank called a blow pit. Here the pulp is drained and washed. A blow pit is a round, oval or square tank with an inclined bottom which is pitched towards an outlet valve; about a foot above the bottom is a false bottom consisting of either drain tile or perforated planks covered with coco matting. A large stack or "vomit spout" extends from the top of the tank to the outside atmosphere, and serves to carry off the steam which is given off when the digester is blown. The liquor in the pulp drains off through the false bottom, and is generally run into the sewer, although some plants are recovering valuable by-products such as alcohol from the waste liquor. After the liquor has drained off, the pulp is washed for from three to five hours by playing a stream of water on the top with a hose or by means of a system of shower pipes placed in the top of the blow pit. When the pulp is thoroughly washed it is diluted with water and pumped or allowed to flow by gravity into large concrete or wooden stock tanks provided with agitators to prevent the stock from settling. The force with which the pulp is blown from the digester to the blow pit opens up and separates the fibres, many of which still retain the form of the original chips, but there are always some uncooked chips present which are not opened up by this treatment, and for this reason the pulp must be passed over coarse screens to remove chips and uncooked portions. The pulp is generally first pumped to rifflers, from which it flows by gravity to the coarse screen. The rifflers consist of troughs with 5-in. boards nailed across the bottom at right angles to and inclined against the flow of the pulp. The riffler serves to catch the heavier materials such as knots, chips, and foreign matter mixed with the pulp. The pulp passes next to the coarse screens, where slivers, chips, and knots are further removed. The coarse screen is generally of the rotary type, and consists of a drum covered with heavy wire screen or perforated sheet metal; the openings in the screen are generally one inch long and about one quarter of an inch in width. The pulp leaving the coarse screen has been freed from chips and large slivers, but still contains small fibre bundles which, if allowed to get into the paper, would show up to disadvantage. To remove these bundles the pulp is next run over flat screens of the type described under the manufacture of groundwood pulp which remove the coarse particles. The screened pulp then passes to wet machines similar to those described under groundwood manufacture, and is taken off in the form of sheets containing about 65 per cent. moisture. When sulphite pulp is to be shipped to the mills it is often run over a sheet-forming machine, and then over heated cylinders and dried, and either shipped in rolls or cut into sheets. Pulp in this condition contains from 15 to 20 per cent. moisture. When the pulp is to be manufactured into paper at the mill itself, it is often simply thickened by means of a feltless wet machine and dumped into vats, from which is pumped as needed.

Soda Process.

In the soda process the separating of the fibres from the wood is brought about by

digesting the wood under pressure and at a high temperature in an alkaline solution. Sodium hydroxide or caustic soda, as it is called, is the alkali used.

Preparation of the Wood.

The wood is prepared in exactly the same manner as for the sulphite process, with the exception that the chipper knives are set so as to produce smaller chips. Chips about ⅝ in. long are considered to be best suited for cooking by the soda process, as the penetration of the liquor is more complete and the cooking more easily carried out.

Digestion of the Wood.

The cooking is performed in either horizontal rotary digesters or upright stationary digesters. The latter are more in use at the present time, and consist of upright cylinders with conical tops and bottoms. They average about 28 ft. in height and 7 ft. in diameter, are made of ⅝-in. steel plate and have no lining, as the caustic liquors do not attack the steel. It is customary to cover the outer surface of the digesters with a lagging of 4-in. insulating material to prevent radiation of heat and consequent condensation of steam in the digester. The chips are charged into the digester in the same way as in the sulphite process, and liquor is pumped in generally at the top of the digester. In case forced circulation of the liquor is to be used, a circular perforated plate is placed in the bottom of the digester and the chips rest on this plate. About 875 gallons of caustic soda liquor of a specific gravity of 1·10 are added per cord of wood charged. Steam passes into the digester at the bottom in case forced circulation is not used; otherwise it enters the top of the digester, passes down through a pipe to the space below the perforated plate in the digester, and is injected into a pipe leading to the space above the chips. As it enters the injector the steam carries with it a certain amount of liquor, which it carries to the top of the digester and sprays over the chips. In this way a very thorough mixing of chips and liquor is ensured. The digester is brought up to a pressure of 100 lb. to 125 lb. in about two hours, during which time the pressure is relieved at frequent intervals by opening a valve in the top of the digester and allowing the accumulated gases to escape. A pressure of 110 lb. is maintained for from five to ten hours, the average time being about eight hours; during this time a temperature 325–330° F. is reached. When the digestion is completed the pulp is blown to a blow pit, where it is washed, and is then screened and run into sheets in the same manner as with sulphite pulp.

The liquor which drains from the pulp contains, beside the soluble lignin and resin compounds, the soda which has been used in the cook, and since soda is a valuable material if the process is to be carried out in an efficient and economical manner, it is necessary that it be recovered and used again for cooking wood.

Recovery Process.

In order to recover the soda present in the liquor it is necessary to evaporate off the water. Evaporation is at best an expensive process, and, in order to lower this cost as much as possible, it is necessary to be extremely careful not to employ too much water in the washing process. With this in view, the pulp is drained in the blow pit, and then dumped into circular steel tanks or pans, as they are called. The pans are fitted with fine screen bottoms, and it is here that the washing takes place. The dilute washings from a previous pan are used for the first washing of the pulp. Then a more dilute washing is pumped over the pan, and the resulting liquor reserved for the first washings of a fresh pan. The final washing of the pulp is done with hot water, and these washings are discharged into the sewer. By this system of progressive washing the soda is washed from the pulp with the least possible amount of water.

The liquor which drains from the blow pit and the washings from the pulp are stored in large storage tanks. From these tanks the liquor flows into multiple-effect evaporators, where it is evaporated to a thick syrupy consistency.

From the evaporators the thick liquor is run into a rotary incinerator. The incinerator consists of a horizontal steel cylinder 14 ft. to 18 ft. long and 8 ft. to 12 ft. in diameter with a firebrick lining. Steel tyres are attached to the cylinder, and these rest upon revolving bearing wheels upon which the cylinder rotates at the rate of about two revolutions per minute. As the black liquor flows in at the back of the incinerator it encounters hot gases from burners at the front, which vaporise the liquor and burn off the organic matter, leaving a residue called black ash, consisting of soda ash and carbon, which is discharged from the front of the incinerator. Considerable excess heat is developed by the burning of the organic matter in the black liquor and is utilised for the production of steam.

The soda ash is dissolved out of the black ash with hot water, care being taken to use as little water as possible for this purpose. The solution is then filtered into causticising tanks, where the soda ash is converted into caustic soda by means of burned lime. When the lime is added to the solution it is first converted into calcium hydroxide, whereupon it reacts with the soda ash, forming caustic soda and calcium carbonate. The caustic soda is soluble, whereas the calcium carbonate is insoluble, so that after a time the calcium carbonate settles to the bottom of the tank and the relatively pure caustic soda solution is drawn off. This caustic soda solution is the

cooking liquor used for the digestion of the wood. Of the caustic soda used in cooking, from 80 to 90 per cent. is recovered and used again, so that it is only necessary to add to each batch of liquor from 10 to 20 per cent. of the caustic soda which would have to be used if no attempt at recovery were made. Since soda ash is cheaper than caustic soda, it is the custom to replenish the supply of caustic soda lost during the process by the addition of soda ash just before the causticising operation. The importance of the recovery process will be appreciated when it is realised that if the recovery of chemicals were not possible the soda process could not, under ordinary conditions, compete with the sulphite process owing to the higher cost of chemicals used in the former process. Some mills are now planning to recover the lime by drying and calcining the sludge from the causticising tanks.

(To be continued.)

POPPY CULTIVATION IN MACEDONIA.

An important industry of Macedonia—and one that has brought excellent returns to the growers—is the cultivation of the poppy plant. Besides the opium extracted from the flowers, an oil is expressed from the seeds that is said to be superior to Russian sunflower oil, and even to English and American cottonseed oil. The residuum, after being pressed into cakes, forms a nourishing food for cattle.

According to a report by the United States Consul-General at Sofia, last year's crop of the poppy plant was most abundant (its estimated value being £100,000, including the flowers, the opium extracted, and the seed produced). The various centres of cultivation contributed to the season's yield in the following amounts :—

District.	Yield. lb.	District.	Yield. lb.
Tikvesh . .	55,000	Kratovo . .	6,600
Veles . . .	55,000	Prilep . .	11,000
Shtip . .	33,000	Kotchani . .	15,400
Kumanovo .	33,000		
Skopie . .	26,400		
Radovish .	6,600	Total	242,000

The prices obtained for the season's crop ranged from 6*d*. to 8½*d*. per oke of 2¾ lb.

The primitive methods of extraction pursued in Macedonia produce but 42 per cent. of oil ; but it is believed that with modern presses the output would be much greater. One-third of the seed suffices for the needs of the country, the remainder being exported. The opium produced is likewise exported, but it has been found impossible to obtain any reliable information as to the probable value of this product.

INVESTIGATIONS OF THE PROPERTIES OF VARIOUS MATERIALS.

Investigations of the properties of various materials, including metals, have been features of recent work at the United States Bureau of Standards, and one of the most important of these was a study of zinc. The Bureau recognises that there is insufficient knowledge of the properties of this material, and has undertaken work which it proposes to have carried out with thoroughness and completeness. Specimens have been prepared for tests in tensions, torsion, transverse, cold bend, compression, shearing, and hardness.

Activities in numerous other lines are of interest to industrial organisations. Considerable progress has been made in the investigation of testing methods for galvanised material which has been carried out in co-operation with the American Society for Testing Materials, while several manufacturers are furnishing the samples.

Progress has been made in the preparation of the test for the joint research with the Pennsylvania Railroad on ingots and their characteristics as shown in the quality of rails made from several types and methods of manufacture. It is also stated that an investigation on rails has progressed to such a point that the reports on the Great Northern Railroad and Pennsylvania Railroad rails which have failed by transverse fissure will be finished shortly, when the chemical work is done. The completion of these reports will make it possible for the redesigning of the alternating stress machine for rail investigation to be pushed to completion.

Work that has been undertaken in connection with ceramics included the study of domestic clays, in making graphite crucibles ; porcelains, particularly pyrometer tubes ; selicon brick ; the investigation with standard brands of firebrick for the Refractories Manufacturers' Association ; the optical-glass investigation ; the use of hydrated lime in Portland-cement concrete ; and the terra-cotta investigation conducted for the National Terra Cotta Society.

The fusible-plug investigation has included the making up of a large series of tin alloys to demonstrate the effect on the melting point of various qualities and kinds of impurities, as well as the effects on tin purity of the use of brass and bronze castings, and modifications in manufacturing methods. Progress has been made also in other investigations, including the study of methods for determining oxides and gases in steel.

Testing of the two series of columns of the American Railway Engineering Association and the American Society of Civil Engineers was temporarily interrupted with the object of studying the data already obtained and making further supplementary tests upon specimens cut

from the columns. A paper on the strength of steel columns in tests has been completed, and it may be published as a technological paper.

A steam vulcaniser has been installed in the experimental rubber laboratory of the Bureau for the purpose of vulcanising rubber tubing. A test of unusual importance was made in the case of thirty-two inner tubes for motor-car tyres submitted by the Post Office Department. The results of these tests are to be made the basis for awarding the contracts.

Other materials which were investigated by the Bureau were clay, magnesite, dolomite mixtures, fire brick, building brick, samples of cement for various contracts, including the Panama contract, leather, lubricating oils, mechanical rubber goods, and paper.

ARTS AND CRAFTS.

Elementary Education and the Supply of Workers in the Artistic Trades.—The prospect of an Education Bill before the end of the present session of Parliament, the various schemes which have been discussed, and the "Educational Policy" put forward by the Headmasters' Association, together with the scheme of the Association of Assistant Masters in Secondary Schools, combine to make all those interested in art and craftsmanship concentrate their attention on the educational problem at the present time. We seem to be faced in the near future with the raising of the school-leaving age. This, it is to be hoped, will mean for the moment not so much that a larger number of children remain later at the ordinary elementary or even central schools as a very large increase in the school accommodation somewhat on the lines of technical and trade schools. Whatever may be the case in the highest ranks of labour or amongst the most intelligent and well-paid artisans, to the ordinary town child of the poorer class the last year at school is already, too often, more or less waste time, not by any means because he is unintelligent, but because he already knows, or thinks he knows, more than his parents, and does not know enough to realise that what he learns at school will be of value in after life (one assumes, of course, that it always will be). What such children need is, above all, the kind of training which at present they get in a good trade or technical school. It is not, as a rule, of much use to talk to them about knowledge for its own sake, or to try to interest them in subjects not in their eyes connected with practical life. How can we expect it to be when so much of their home life is taken up with the mere struggle for existence? Their first desire is quite naturally (can we say quite wrongly?) for material well-being. Once they get into a good trade or technical school and are taught to see the connection between education and practical life, they are willing and even eager to learn—at first, perhaps, simply because they think it will mean better pay when they go out to work, later, often enough, from real interest. The assistant masters seem to realise and provide for this by their suggestion that children should be, in most cases, moved into a different type of school at about the age of twelve. There is, of course, on the face of it a good deal to be said for giving the children more general education before they go to the trade schools. But before such a scheme would be really beneficial, for the children of the poor districts of London at least, the elementary education wants a good deal of adjustment. The crying need. in the case of the older boys at any rate, is to make them really interested in their school-work. At present, too often, their interest is not awakened until they have left school and begun to see for themselves that education in the long run pays. Perhaps, for this reason, the most promising part of the education schemes seems to some of those who are not professed educationalists to lie in the proposals to ensure that boys and girls who have left school at the age of fourteen or sixteen shall have opportunity to continue their education at times when they are not already tired out by an overlong day's work. All this is not so remote from the region of art and craftsmanship as it may sound, for it is to the workers themselves that we must trust in very large measure for that improvement, technical and artistic, in our industrial output for which we are hoping after the war, and they will be able to co-operate (broadly speaking) in proportion as their education and training have fitted them to do their part intelligently and sympathetically.

Meanwhile, the effect of the war on both central and technical schools has been bad. In the former the boys are too often taken away (in spite of their parents' undertakings) directly they are fourteen, so that the higher classes are depleted and the trade schools, whether for boys or girls, are not so full as they ought to be, though the young people who are in them show a most satisfactory enthusiasm for their work. This seems to indicate that if we could only increase the number and scope of such schools we should be moving in the right direction. There appears to be an idea abroad that in the case of boys who will be called up for the army at the age of eighteen there is a certain amount of wastefulness in training them for industrial occupations, and parents are shy of leaving their children at school that they may qualify for a calling which they will possibly never follow. But after all, the war cannot go on for ever, and we are already talking about reconstruction. In the meantime, it cannot be insisted upon too strongly that the training in schools of this type does not turn the pupils

into machines better qualified than they would have been without it to do one type of work, but into intelligent, alert human beings, better fitted than they could have been without it to put their hand to whatever craft comes along. One hears of girls trained primarily as upholsteresses turning one of the minor branches of their trade to account, and not only earning good wages as machine embroideresses, but realising that they will need to know more of hand-work; whilst the boys prove repeatedly that their school-work has not been in vain. That such things happen is partly due to the technical training, but also in no small measure to the education in the principles of art which many of them have received.

One feels amidst all the talk which is going on about education and reconstruction that there is really very little evidence in the sphere of art and craftsmanship of any efficient preparation for what one hopes will be the immense opportunities which will open out after the war. The art schools are naturally labouring under enormous disadvantages. It hardly seems to occur to the ordinary person that those at present engaged in teaching art in any form may, in the truest sense, be doing national service, though at least one important town has brought forward a scheme for co-ordinating art and technical training after the war. But concerning technical schools there certainly should not be the same difficulties. The students are younger, they do not even at present consist solely or mainly of girls, and it is to them that in the near future more than ever before we shall have to look for the kind of workpeople who will be needed. It does not take much foresight to see that the work of such schools is really of national importance. In what way, then, does the teaching in these schools differ from that of the ordinary schools? It is worth while to take a concrete case—in a trade more closely connected with art than most—wood-carving. The boys at the School of Art Wood-carving, South Kensington (which is not at present a technical school in the Board of Education sense, but which trains boys to enter the trade as well as teaching other students), besides being instructed in carving, continue their ordinary school work; but their arithmetic is correlated to their main subject, and their history leans towards architecture. They learn modelling because it helps them in the carving, and design and the history of ornament that they may understand what the various styles stand for when they get into the workshop. If at present when they leave school they do not find employment as carvers (some do and some do not), they can at once do valuable work in the construction of aeroplanes, and some of those who have been called up for military service are doing work, even in the Army, in which their grounding tells. In the training of embroideresses at the various trade schools much the same plan is followed. In both cases the children see for themselves the usefulness of what they are doing, and, in consequence, find it worth while.

It was perhaps because this practical element was so often missing that the ordinary art schools of days gone by were not more effective. It is to be hoped that in the time that is coming they will attract more and more of the students who have been trained in technical schools, that they will encourage and not look down upon "trade work," and that in them the trade students will find the help which is so often needed to keep a man from getting so immersed in trade conditions that he forgets the claims and the inspiration of art. In all teaching, especially in the teaching of art, there is, of course, room for and need of the ideal; but under existing conditions in our large cities we fail if we do not, in dealing with children of twelve years old and upwards, appeal also to their practical side. It is really only after satisfying its demands that the soil is prepared for the ideal to grow.

OBITUARY.

General Andrés A. Comerma.—General Andrés A. Comerma, of the Royal Spanish Navy, died at Ferrol, Spain, on May 11th. He was born in Valls in 1842, and studied civil engineering and afterwards naval architecture in the college at Ferrol. In 1866 he was appointed Naval Constructor at the Spanish Government Dockyards at Ferrol, and during the period of this appointment he designed and carried out the construction of the San Julian Dock, the largest dry dock in Spain at that time. This important undertaking was commenced in 1873 and completed in the year 1879. In 1880 he served on the Spanish Naval Commission in London, and afterwards was attached to the Embassy here. He was present at many congresses held in different countries, among them the Fisheries Commission held in London in 1883; the Electrical Congress at Munich in the same year; and in 1900 he was Vice-President of the Engineering Congress held in Paris. In 1881 he attended the International Congress in Paris, at which the electrical units were established, and for his labours in this connection he received the decoration of the Legion of Honour.

In 1889 he undertook the management of a private shipyard at La Graña (Ferrol), which turned out important work for the Government, including the building of the gunboats "Alvaro de Bazan," "Marqués de la Victoria," and "Maria de Molina." In 1884 he was appointed shipyard manager at Ferrol Dockyard, and built the cruisers "Reina Cristina" and "Alfonso XII."

He was the author of several works on naval architecture; was a member of the Institute of Naval Architects; and in 1913 was elected a member of the Spanish Royal Academy of Science. He had been a member of the Royal Society of Arts since 1880.

GENERAL NOTES.

THE UTILISATION OF IRISH PEAT DEPOSITS.—The Fuel Research Board, with the sanction of the Committee of the Privy Council for Scientific and Industrial Research, has appointed a committee of inquiry into the utilisation of Irish peat deposits. The terms of reference to the committee are as follows: "To inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation, and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which, in the most favourably situated localities, it can be profitably won, prepared and used, having regard to the economic conditions of Ireland; and to report to the Fuel Research Board." Though the inquiries of the committee will ultimately lead up to the consideration of peat as a source of energy in central power stations, there are sound reasons why this aspect of the problem should be postponed to a later stage. On the one hand, the Fuel Research Board is already organising an extensive inquiry into the problems of fuel economy in connection with power production, and the results of this inquiry will supply the fundamental data and information which will be required when the time comes for the consideration of any wide scheme of development in Ireland. On the other hand, any schemes of development must be based on a more exact knowledge than is at present available regarding the selection of the more favourably situated bogs and the possibilities of winning and transporting partially dried peat to centres at which it may be converted into marketable products. It is obvious, therefore, that the inquiries of the committee are likely to be most fruitful if they are concentrated on the fundamental problems, for until these are settled no satisfactory progress can be made. All communications should be addressed to the Secretary, The Peat Inquiry Committee, University College, Dublin.

THE JAPANESE CEMENT INDUSTRY.—In Japan the cement industry is reported as particularly flourishing, the output having increased, according to the *London and China Telegraph*, from 3,741,000 barrels in 1913 to 3,943,000 barrels in 1915 and a still greater output in 1916, while exports have increased from practically none five years ago to 668,000 barrels in 1915 and a still larger export in 1916. Japan's sales have been particularly heavy in the South Seas, and a considerable trade has been built up in India, the trade in the South Seas being almost entirely at the expense of Hong-Kong and the German trade. Japanese newspapers predict an output of nearly 12,000,000, barrels within two years. The Hong-Kong industry is in better shape than it has been, although the business is more restricted. Cement from the United States will have no part in the trade so long as present freight rates obtain.

VICTORIA AND ALBERT MUSEUM.—Last year the Victoria and Albert Museum was fortunate enough to obtain the painted bedstead, with its original Indian cotton hangings, which was made between 1770-1775 for David Garrick's villa at Hampton. The bedstead was presented by Mr. H. E. Trevor, a descendant of David Garrick's brother George; and now, through the generosity of this gentleman with the co-operation of some admirers of David Garrick, the Museum has secured the rest of the contemporary furniture which was made for the Hampton bedroom. These consist of three wardrobes, a corner cupboard, a basin-stand, a dressing-glass and five chairs. With the exception of the dressing-glass, all the furniture is decorated in green and yellow, in the same manner as the bedstead, some pieces having designs of Chinese figures and landscapes. The dressing-glass is supported by snakes in carved and gilt wood, and is decorated in a style designed to suggest Dresden china. Apart from its historic interest, the furniture presents an attractive scheme of decoration which should be useful to modern artists and decorators.

OFFICIAL SCIENTIFIC STUDY OF DEXTROSE.—The United States Bureau of Standards has recently published a report, "Scientific Paper No. 293," which treats of the saccharimetric normal weight and the specific rotation of dextrose. The essential constituent of glucose is a sugar which is called dextrose or dextrose-glucose. This, when pure, is a white crystalline substance which may be analysed in much the same manner as cane sugar on the polariscope. if it is once known how much dextrose is required to give a reading of "100" on the scale of the instrument. The Bureau find that 32·231 grammes of pure dextrose will read "100 per cent." on the polarimeter. The percentage of dextrose present in any sample can then be read directly. The paper gives data for correcting the readings, so as to give the most accurate results. For many purposes it is useful to know the rotary effect of dextrose upon polarised light of a single pure colour. This was investigated, and was stated for green light emitted by the mercury arc. Copies of the report may be obtained from the Government Printing Office, Washington, D.C.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

EXAMINATIONS.

The results of the Intermediate (Stage II.) Examinations, held from May 14th to the 23rd, were sent to the centres concerned on July 31st. The results of the Elementary Stage will be published about the middle of this month.

THE PULP AND PAPER INDUSTRY IN CANADA.*

By O. F. Bryant,

Chief of the Division of Pulp and Paper, Forest Products Laboratories of Canada, McGill University, Montreal.

(*Continued from page* 627.)

Sulphate Process.

The sulphate process is the latest process of any great importance which has been developed for the production of pulp. The first mill to make sulphate pulp on this continent was erected in Canada about ten years ago. Like the soda process, it is an alkaline process, but, in addition to caustic soda, sodium sulphide is employed. The principal use of sulphate pulp is for the manufacture of "kraft" papers—the extremely strong brown wrapping paper so much used at the present time. Thanks to the strength of sulphate pulp, papers of the desired strength can be obtained with less bulk and weight than by any of the other processes.

Owing to the nature of the process, a larger variety of woods can be used for the production of pulp than by any other process. Spruce, balsam fir, jack pine, tamarack, long-leaf pine, short-leaf pine and Douglas fir have been successfully treated by this process, and a number of mills have operated almost entirely on the waste of saw-mill and lumbering operations.

Preparation of the Wood.

The wood is prepared in a manner similar to that of the sulphite and soda processes, with the exception that the chipper knives are so set as to produce a chip about 1⅛ in. long. In some mills very little care is exercised in cleaning the wood since the cooking liquor dissolves the bark, and in a few mills the bark is not removed at all. The latter, however, is poor practice, as chemicals are consumed in dissolving the bark without a corresponding production of pulp.

Digestion of the Wooa.

There are two types of digesters used for cooking wood by the sulphate process, namely, the vertical stationary digester and the vertical revolving digester. The former is similar to that used in the soda process, and is from 3 to 5 tons capacity. The vertical revolving digester, which revolves about its short axis and is sometimes called a "tumbling" digester, is ordinarily about 28 ft. long, 9 ft. in diameter, with conical ends. The maximum capacity of such a digester is 2½ tons. The digester is made of welded steel, is unlined, and revolves on hollow trunnions through which steam is admitted. The digesters are usually lagged with insulating material in order to avoid excessive condensation in the digester and the consequent waste of steam. The cooking is carried on at a pressure of 80 lb., superheated steam being employed, and the length of cooking varies from two to eight hours, three hours being the average cooking time. At the end of the cook the pulp is blown under 60 lb. pressure either into blow pits, from which it is dumped into open wash tanks, as in the soda process, or directly into closed wash tanks called "diffusers." The latter is the practice in modern sulphate mills, and it is claimed that a much more efficient recovery of chemicals is obtained by this method.

The diffusers are upright cylindrical tanks, each of sufficient capacity to handle one digester charge. They are provided with perforated false bottoms placed about 1 ft. above the bottom of the tank, and are connected at the top on a common tank called the "save all." When the pulp is blown into the diffuser a considerable amount of steam is liberated, which is carried by means of the connecting pipe to the "save all" tank. Here any pulp carried mechanically by the steam is trapped, and the steam is condensed and sent to the wash tank to be used for washing

* Extracted from an article in the *Pulp and Paper Magazine* of Canada.

the pulp. The steam from various points in the process is passed through a coil in the bottom of the wash tank, thereby heating the wash water, while the steam condensed in the coil is also run into the wash tank, thereby increasing the supply of wash water.

The pulp which has been blown into the diffuser is allowed to drain, and the liquor, called "black liquor," is collected in the black-liquor storage tank. As soon as all the liquor possible is drained off, the washings from another diffuser considered too weak to go to the black-liquor storage tank are pumped on top of the pulp. This weak liquor forces more of the black liquor out of the pulp into the black-liquor storage tank, partially mixing with it; when this liquor becomes too weak to run into the storage tank it is pumped to the top of another diffuser and used for washing the strong liquor out of the next cook, while pure water is admitted at the top of the first diffuser and sprayed over the pulp. When the solution coming from the bottom of the diffuser becomes too weak to use for washing the next cook, it is run into the sewer, and the washing with water is continued until the washings are clear, or nearly so. The water used for washing purposes comes from the hot-water tank, and is at a temperature of about 125° F. By using this system of washing the liquor is removed from the pulp with a minimum amount of water, and the subsequent recovery process is considerably simplified.

The pulp which comes from the digesters, especially in the case of kraft pulp, is not completely cooked and the fibres still cling together, retaining the form of the original chip. It is now necessary to break up these chips into individual fibres, and this is accomplished by means of an "edge-runner," "kollergang," or "crazy chase," as it is variously called. The kollergang is made up of a circular iron or stone trough round which two heavy stone rolls travel. The stone rolls, which resemble mill stones, are mounted on a horizontal shaft in such a way that they revolve as they travel round the trough. The pulp is shovelled into the trough, and as the stones travel they crush up the chips and rub them out into individual fibres. The stones are generally made of granite or basalt lava, and the trough when made of stone is composed of one of these materials. After the pulp has been kollerganged it is screened and run into sheets, just as in the sulphite and soda processes.

Recovery Process.

In order to recover the soda present in the black liquor, it is necessary to resort to evaporation, as in the soda process. There are two types of evaporators which may be used for this purpose, the multiple-effect evaporator and the disc evaporator. These evaporators may be operated individually or in conjunction with one another, and the most up-to-date plants use both types of evaporators. The black liquor is first pumped to the multiple-effect evaporator, which has been described under the soda process, where the liquor is partially concentrated, from which it runs into the disc evaporator. The latter consists of a horizontal drum in which revolves a shaft with iron plates attached. The lower part of the drum is filled with the liquor to be evaporated, and the plates are so arranged on the shaft that during part of a revolution they are completely submerged in the liquor, while during the remainder of the revolution they are out of contact with it. Heat is supplied in the form of hot gases from the rotary and melting furnaces, and as the plates dip into the liquid a portion of it adheres to their surfaces, thus exposing an extremely large liquid surface to the action of the hot gases. Either two or four drums of this description are placed behind each rotary and melting furnace.

The concentrated liquor, now containing approximately equal weights of water and solid matter, flows by gravity into the rotary furnace or incinerator. This furnace is similar in construction to the incinerator described under the soda process. It may be of either the short or long type, the former being from 15 ft. to 20 ft. in length and 8 ft. in diameter, the latter being about twice as long. The long type is often divided into two compartments, the front section being lined with firebrick, the back section being unlined and provided with iron plates which extend into the furnace and serve as lifts for agitating the material during its passage. The material travels through the furnace from back to front, while the hot gases pass in the opposite direction. As the material approaches the front of the furnace, becoming more and more concentrated, it catches fire and finally falls out of the front of the furnace in the form of a moist black mass. From here it is shovelled by hand into the melting furnace situated below the front of the rotary furnace. In the melting furnace the organic matter is completely burned out of the black ash, as it is called, and the heat generated in this action is carried through the rotary furnaces and disc evaporators, evaporating moisture in its passage, the excess heat being utilised to generate steam.

During the cycle of operations a certain amount of soda is unavoidably lost, and this has to be replaced. While in the soda process the deficiency of soda was made up with soda ash, in the sulphate process the soda lost is renewed by the use of salt cake or sodium sulphate. A certain amount of salt cake is added to the black ash as it is shovelled into the melting furnace and is reduced to sodium sulphide by the carbon present in the black ash, in which form it goes to the digesters. It is important to note that the salt cake is of no importance in itself in the digestion of the wood, and it is only of use when converted to sodium sulphide. It is from the use of salt cake or

sodium sulphate that the sulphate process derives its name.

A very high temperature is maintained in the melting furnace where the carbon is burned from the black ash, the salt cake reduced to sodium sulphide, and the salts melted and discharged from the furnace at a temperature of about 3,000° F. The molten salts flow into a tank, situated directly below the melting furnace, which is filled with the washings of the lime sludge, which will be described a little further along. This tank is covered, with the exception of an opening for admitting the melted material from the melting furnace, to prevent the splashing out of the liquor when the melted salts come in contact with the water. This tank is provided with an agitator to stir the liquid, and is of such a size as to supply one complete charge to the causticiser.

The molten salts discharged from the melting furnace, and consequently the solution of these salts, contain sodium carbonate (soda ash), sodium sulphide and sodium sulphate (salt cake). In order to obtain an effective liquor for digesting the wood it is necessary to convert the sodium carbonate to sodium hydroxide (caustic soda), and this is accomplished, as in the soda process, by the action of lime on the soda ash. From the dissolving tank the solution is pumped to a large tank called the causticising tank, where lime in a steel basket placed in the liquor reacts with the soda ash, forming caustic soda. During the causticising process the solution is boiled for from twenty to thirty minutes, during which time the agitator with which the tank is provided is kept running. The steam is then shut off and the agitator stopped to allow the insoluble calcium carbonate formed in the reaction to settle. The settling of the sludge occupies a period of about two hours, after which the clear solution is syphoned off into a storage tank.

When the liquor has been drawn off, the causticiser is filled with weak liquor consisting of the second and third washings of a previous sludge, the steam turned on, the agitator started and the processes repeated. This first washing of the sludge is added to the liquor which has just been pumped to the storage tank. The liquor in the storage tank is now ready for use in the digester for cooking the wood. The composition of the liquor varies in different mills, but the following is the composition of a liquor used by one mill :—

28 per cent. caustic soda,
28 per cent. sodium sulphide,
8–10 per cent. soda ash,
37 per cent. salt cake.

This liquor, with from 10 to 30 per cent. by volume of the original black liquor, is used in cooking wood for the production of kraft pulp.

The second and third washings of the sludge are pumped to storage tanks, and used for washing the sludge from the next causticiser and dissolving the molten salts coming from the melting furnace.

Bleaching.

For all ordinary grades of paper, such as newsprint, coloured wrapping, etc., sulphite pulp can be used as it comes from the wet machines after the washing and screening processes. In case it is desired to manufacture white papers, it is necessary to bleach the pulp in order to remove the colouring matter which it still retains. Soda pulp which is used in book papers, etc., is always bleached; sulphite is bleached when it is to be used in high-grade white wrapping papers, bonds, etc., and the sulphate pulp is sometimes bleached.

The bleaching process consists in immersing the pulp in a solution of calcium hypochlorite, otherwise known as bleaching powder. The bleaching powder oxidises the colouring matter and renders it soluble so that it can be washed from the pulp, leaving the latter almost pure white.

The bleaching powder solution is prepared by placing a certain amount of bleaching powder in a tank with water. The tank is equipped with an agitator, which stirs the mixture until practically all the calcium hypochlorite is in solution. The solution is then run into settling tanks, where the insoluble matter is allowed to settle out and is syphoned off into measuring tanks, from which it is mixed in the desired quantities with the pulp.

A great many mills nowadays manufacture their own bleach from salt, as they find it more economical than buying it from the bleach manufacturers. In case this is to be done, a solution of common salt is run into an electrolytic cell, where it is broken up by the action of an electric current into chlorine gas and caustic soda solution. The caustic soda solution is evaporated and either sold or, in case soda pulp is being manufactured, utilised at the plant. The chlorine gas is conducted into tanks containing milk of lime, where it combines with the lime, forming a solution of bleaching powder. The solution is allowed to settle, and is then syphoned off and used in exactly the same way as the above-described solution made from bleaching powder.

There are two general systems for bleaching pulp—namely, the tank system and the bleaching-engine system; all other systems are modifications of these two systems. When bleaching by the tank system the pulp is placed in a tank provided with some sort of stirring apparatus, and the bleaching solution or bleach liquor, as it is called, is added. The mixture is stirred until the pulp is bleached, which takes from three to four hours, after which it is dumped into tanks with perforated tile bottoms, where the residual bleach liquor and soluble colouring matters are washed out. When the pulp has been thoroughly washed it is pumped to wet

machines and formed into thick sheets, and is now ready to be made up into paper.

The bleaching engine which is used in the second system consists of a shallow oval-shaped vessel divided lengthwise by means of a partition called the "mid feather," which, however, does not extend to the walls of the apparatus.

In one of the two channels into which the tub is divided a heavy roll fitted with steel knives revolves. Below the roll on the floor of the tub is a fixed "bed plate," also provided with projecting steel knives lying parallel to those of the roll. The distance between the knives of the roll and those of the bed plate may be altered by raising or lowering the roll by means of adjusting screws. In the other channel there is placed a "drum washer," which serves to remove the dirty water from the pulp. The drum is divided into sections by means of partitions, and the surface of the drum is covered by a fine brass wire cloth supported and strengthened by a coarse cloth underneath. The pulp is placed in the engine with the bleach solution, and the passage of the pulp and bleach liquor between the roll and the bed plate serves to break up the pulp and intimately mix it with the liquor. After the mixture has circulated for about three hours the drum washer is started and clean water is run into the engine. The residual bleach liquor and colouring matter is carried out of the pulp by the drum washer, and the pulp is washed clean with the water. From the bleaching engine the pulp is dumped into storage tanks and then run over the wet machines to remove the excess water and to form it into sheets. In case the bleached pulp is to be used at the plant, it may be dumped directly from the bleachers to stock tanks and pumped to the beaters as required.

Depending upon the kind of pulp used and its previous cooking treatment, from 10 to 25 per cent. of its weight in bleaching powder is required to bleach it. A loss of about 10 per cent. in weight is sustained by the pulp during the bleaching process, which loss is due to the colouring matter and other impurities removed by the bleach liquor.

The Manufacture of Paper.

The production of paper from pulp divides itself into four main operations—namely, beating the pulp, felting the fibres, removing the water and finishing the paper. The principle of making all kinds of paper is the same regardless of whether we are dealing with newsprint or high-grade writings, although some of the operations differ in detail.

Beating.

The pulp is placed in a machine known as a beating engine or beater, which is very similar to the bleaching engine described under bleaching in that it consists of an oval-shaped tub with a partition through the centre in the lengthwise direction extending to within a short distance of the ends of the tub. This partition, or "mid feather," divides the beaters into two channels, in one of which revolves a heavy roll fitted with projecting knives extending along the face of the roll. Below this roll, on the floor of the channel, a "bed plate" fitted with knives parallel to those of the roll is fixed. Behind the roll a sort of dam or "back fall" keeps the pulp from backing up against the roll. The roll is equipped with a raising and lowering device so that the distance between it and the bed plate may be varied.

Pulp and water in the proportion of about 1 to 20 are placed in the beater, and in passing between the roll and the bed plate the pulp is thoroughly disintegrated and separated into individual fibres. If the fibres are too long for the particular grade of paper being manufactured, they are cut by bringing the roll knives down close to the bed-plate knives. The pockets between the projecting knives of the roll catch the pulp and, acting like a bucket wheel, throw the stock over the "back fall," in which manner the stock is kept circulating round the beater. If stock is circulated for a long time in the beater a peculiar action takes place, in which the cellulose fibres take up water and become greasy or slimy. Advantage is taken of this fact in the manufacture of "glassine," "grease-proof" and other papers of this nature. If the pulp is to be coloured the dyes are added during the beating process in order that they may be well mixed with the pulp. The material for rendering the paper more or less waterproof is also added at this point. This operation is known as "sizing" the paper. The size consists of resin cooked with soda, the proportions being so adjusted that there is an insufficient quantity of soda ash present to convert all resin into resin soap, and some "free" or uncombined resin will be left suspended in the resin soap. This mixture of resin and resin soap is then agitated and thoroughly mixed with water in one way or another, and made up to a very dilute solution containing about 2 lb. of resin size to 98 lb. of water. This size resembles milk to a considerable extent, and for this reason is known as "milk of size." The size solution is added to the pulp in the beater and thoroughly mixed therewith, after which a solution of alum is added to precipitate the resin upon the fibres. The resin is precipitated in a finely-divided state upon the individual fibres, and in the subsequent drying operation melts and, on cooling thoroughly, closes the pores of the paper, making it more or less ink- and water-proof. When the pulp is thoroughly beaten it is emptied into stock tanks, from which it is pumped to the Jordan engine or refiner, as it is called. The Jordan engine consists of a hollow cone lined with knives similar to those of the beater roll. A movable conical plug with knives projecting from the surface fits inside the hollow

cone. The plug can be moved backward and forward in the direction of the axis of the cone, thus either increasing or decreasing the distance between the knives of the cone and those of the plug. The beaten pulp passes through the cone between the knives of the rotating plug and the stationary knives of the cone, and is brushed and cut to the proper condition for the production of paper. After passing through the Jordan engine the pulp is run into "stuff" chests provided with agitators.

In spite of the careful treatment that the pulp has received, there are still some fibre bundles, slivers, etc., which must be removed before the pulp is made up into paper, and to accomplish this the pulp must be screened. The pulp is pumped from the stuff chests to a regulating or "head" box placed above the paper machine, and serving the purpose of furnishing a constant supply of pulp to the machine. The box is so arranged that more pulp than is needed by the machine is pumped to it, the excess pulp flowing back from the box to the stuff chests. After the pulp leaves the head box it is diluted with water to such a point that for every pound of pulp present in the mixture there is about 150 lb. of water. This mixture is then passed through flat screens to remove the coarse material, and the fine fibres pass on to the flow box of the paper machine.

Felting the Fibres and Removing Water.

The flow box is a long narrow box placed at one end of, and extending the full width of, the paper machine. The pulp flows into this box, where, by an arrangement of baffle plates or a stirrer, as the case may be, the pulp is thoroughly mixed with the water. From the box the mixture flows through an opening or slot to an endless woven wire-cloth known as the machine wire. The pulp is transferred from the box to the moving wire by means of an apron, a thin rubber sheet, one end of which is attached to the box and the other allowed to rest upon the moving wire.

The paper machine proper is divided into two parts, the wet end and the dry end. At the wet end the pulp is formed into a sheet of paper, and a portion of the water is removed by draining, while at the dry end the remaining water is removed by drying with steam and the finishing operations take place.

The wire upon which the pulp flows from the flow box is an endless brass cloth from 40 ft. to 75 ft. in length and 70 ft. to 202 in. wide, with a mesh of from 60 to 80 wires per inch. It runs over two rolls, the breast roll situated near the flow box and the lower couch roll. Between the breast roll and the couch roll are a series of table or tube rolls, over which the wire passes and which serve to support it. The path of the wire is from the breast roll over the table rolls, between the upper and lower couch rolls, and back under the machine to the breast roll. Beneath the machine are several small rolls which serve to guide the wire and keep it tight.

As soon as the pulp flows on to the moving wire it passes under the slice, a brass bar set on edge extending across the entire width of the wire. This bar is adjustable in height and width, and serves at least three purposes: (1) by varying its height above the wire the thickness of the pulp mixture flowing on to the wire and consequently the actual thickness of the paper may be varied; (2) by adjusting the flow of stock from the flow box, so that the mixture extends some distance above the bottom of the slice, the stock is dammed up and a hydraulic head produced which may be varied and the speed with which the stock flows on to the wire thereby changed; (3) by the damming action a pool of stock is formed behind the slice which, in conjunction with the shake, aids in the felting of the sheet.

To prevent the pulp from flowing over the edges of the machine, wire "deckle straps" are used. These consist of heavy endless rubber bands of square cross section placed on each side of the wire. They are carried on wheels above the wire in such a way that their bottom side is in contact with the wire and travels with it. In this way the straps form sides which confine the pulp to the wire.

The speed with which the stock flows on to the wire causes all the fibres to lie in such a position that their long axis is pointing in the direction in which they are travelling. Since a paper whose fibres are all parallel is generally very weak, it is necessary to distribute some of the fibres at right angles to the others. This is accomplished by shaking the frame on which the wire travels by means of an eccentric. The frame is given about 175 shakes a minute, and this causes the fibres to interlock and become well "felted."

As soon as the pulp strikes the wire water begins to drain away, and this drainage is hastened by the capillary action of the table rolls and by suction boxes. Two or more suction boxes are placed beneath the wire. The tops are generally of wood, perforated, and the boxes are connected with vacuum pumps, which draw the water from the pulp as it passes over their tops. The water which drains from the wire contains a considerable portion of fine pulp which must not be wasted, and for this reason a large shallow box or "save all" is placed under the wire, which catches the water as it drains through. This water is used for diluting the pulp from the stuff chests before it flows to the screens, and the surplus is either used in the beaters or passed through a fine wire screen which removes the pulp and allows the water to flow to the sewer. By the use of such "save alls" a considerable saving in pulp is brought about.

Between the suction boxes the paper is submitted to the action of the "dandy roll,"

a skeleton roll faced with wire cloth, which revolves on the surface of the wet paper and presses it, giving the upper surface of the paper the same appearance as the lower side which is in contact with the machine wire. If the paper is to be water-marked, raised wires in the form of water-mark desired are sewn or soldered to the wire surface of the dandy roll, and the impressions of the raised pattern on the wet paper causing a thinning of the pulp at that point results in the formation of the water-mark.

Upon leaving the suction boxes the wet paper is carried by the wire between two "couch rolls," the upper one being of wood or iron and covered with a felt jacket. The action of the couch roll is to press the fibres together to form a more compact sheet, and to remove some of the water still present in the paper. The wire passes around the lower couch roll and back under the machine to the breast roll, and the paper passes from the wire to an endless felt, which carries it between the press rolls. These are heavy iron or stone rolls, which serve to press the sheet together and make it more compact; they also remove a small amount of water. The paper machine is usually provided with two or more presses, so that the paper may be passed through one set and back through the other set to give both sides of the sheet the same finish.

Drying the Paper.

The wet paper leaving the press rolls still contains about 70 per cent. of water which cannot be removed by draining and squeezing. It is, therefore, necessary at this point to resort to heat for removing the moisture, and for this purpose large drying cylinders are used. These consist of large hollow cylinders somewhat wider than the paper, and from 3½ ft. to 5 ft. in diameter, heated internally by steam, generally the exhaust steam from the engines driving the machine, and provided with syphon pipes or dippers for removing the condensed steam. According to the weight of the paper made and the speed at which the machine is run, there are from twelve to forty dryers used. The paper is led over these cylinders by means of endless felts, which press the paper against the hot surface of the dryers. The dryers are placed in two or more rows, one above the other, and the paper is passed from a top dryer to a bottom dryer, back to a top dryer, and so on in such a manner that first one side of the paper and then the other is in contact with the surface of the dryers. The water is slowly evaporated from the paper in its passage over the dryers, so that when the sheet leaves the last drying cylinder practically all the water has been removed.

Putting on the Finish.

With ordinary "machine finish" papers, such as newspapers, wrapping papers, etc., the paper after leaving the dryers is passed through calender stacks to give it the desired finish. A calender stack consists of a number of heavy, highly polished, chilled iron rolls; the rolls are in contact, lying one above the other, and, in addition to their own weight, extra pressure can be exerted between them by means of a system of weights and levers. The paper is threaded between the rolls, and the finish is imparted by the pressure and rubbing action of the rolls. When a high finish is desired, the paper is moistened before it is calendered, and in many cases one of the rolls in the stack is steam-heated. When treated in this way the paper is said to be water-finished. When a very high finish is desired, the paper is pressed through additional calenders called "super-calenders." The super-calender is made up of alternate chilled iron rolls and rolls of compressed cotton or paper; the rolls are very heavy, and a great pressure is obtained by means of weights and levers. A high degree of finish is obtained by passing the paper several times through the super-calender.

Other Grades and Finishes.

High-grade writing papers are sized with gelatine to improve their surface and sizing qualities. With the cheaper grades the sizing is often carried out on the paper machine itself, whereas the better grades are sized on separate sizing machines. When the paper is to be sized on the machine, a tub containing a solution of gelatine is placed between the drying cylinders near the end of the paper machine. The dried paper is passed through the gelatine bath, then between squeeze rolls to remove the excess of gelatine, and finally dried either by steam-heated dryers or by passing over skeleton rolls through which hot air is blown. After the paper is thoroughly dried it is run either through super-calenders or plate-glazing machines. The operation of the plate-glazing machine is as follows: The paper is first cut into sheets of the proper size, which are then built up in a pile with zinc plates between the sheets. When the pile is large enough it is passed between rollers, where a great pressure is given; the pile is passed through the rolls a sufficient number of times to give the desired finish.

Coated papers are those which, after passing over the paper machine, are given a mineral coating to produce a smooth surface for fine printing work. The paper used for half-tone engravings in magazines and books is almost always a coated paper. The paper itself is generally of a good grade and fairly well sized, but is not given a very high polish. The mixture used for coating is generally made up of china clay, glue and water, but calcium of barium sulphate may be used in place of the china clay, and casein often replaces the glue. The paper in the form of a roll is placed at the back of the coating machine, which is a large drum about 4 ft. in diameter and 4 ft. wide. The paper passes under the drum and then over

the top, and during its passage is brought in contact with an endless felt, which transfers the coating mixture to the paper. This coating mixture is fed continuously into a trough on the front of the machine, and is maintained at a constant level. The coating mixture is transferred from the trough to the felt by means of a copper roll rotating in the mixture, and the excess of coating material is removed from the paper by passing it between squeeze rolls. In order to ensure perfect adhesion and a smooth surface, the coating mixture is rubbed into the paper by means of stationary and oscillating brushes which operate on top of the drum. The paper then passes to the drying apparatus, which consists of two overhead rails upon which an endless chain carrying a series of sticks travels. The paper is caught on the sticks, carried up to the rails, where it falls into a series of loops, at the same time moving slowly forward on the rails. A current of hot air is blown against the paper to aid in drying. After drying, the paper is reeled up and taken to the super-calenders, where a high polish is imparted to the sheet. Because of the extreme smoothness of the surface of coated paper it is very suitable for printing half-tones.

Packing and Shipping.

The final finishing operations consist in cutting, sorting, and packing the paper in bundles. Newsprint is generally sold in the roll, but sometimes in sheets; wrapping paper is furnished in both rolls and sheets; while writing paper is always sold in sheet form. The cutting into sheets may be done automatically by means of rotating knives, or by a combination of machine and hand labour, in which a guillotine cutter with a knife moving up and down is used. After cutting, the paper is carefully inspected for defective sheets, and is then counted out into reams of 480 or 500 sheets. Several of these reams are tied up together in wrapping paper, and are shipped from the mill in this condition.

Growth and Importance of the Industry in Canada.

Because of her great timber resources, together with abundant water powers, Canada has the opportunity of becoming the greatest pulp- and paper-producing country in the world. Never in her history were conditions so advantageous for the development of the pulp and paper industry, and probably never again will a combination of circumstances bring about such opportunities as exist now, and will exist for the next few years. So far as industrial development is concerned Canada is a young country, and with a relatively small population the tendency has been to export the raw materials with which she is so abundantly provided, and to import in turn the finished products for the consumption of her people. This is a natural condition when a country is young industrially, when the population is small, and when capital is not at hand for the development of industries. But the time has come when she should no longer send her raw materials to other countries, but convert them into finished products within her own boundaries, exporting the manufactured article, and thereby reaping the profits which have been going to others.

It is interesting to note that in 1908 of all the pulpwood cut 64 per cent. was exported in the raw state and 36 per cent. manufactured into pulp, whereas, in 1915, 59·6 per cent. of the pulpwood was manufactured into pulp, and only 41·4 per cent. exported in the raw state. From 1908 to 1915 the exportation of pulpwood increased only about 6·7 per cent., whereas the pulp exports increased 190 per cent. Since the middle of 1912, the wood manufactured into pulp in Canada has been increasingly greater than that exported in the raw state.

Abundant supplies of timber and cheap water power, with which Canada is amply supplied, are the prime requisites for the production of groundwood pulp, while coal enters largely into the manufacture of chemical pulp. Some of the minor chemicals required, such as sulphur, are not produced in Canada, but are easily obtainable. For these reasons the pulp and paper industry should increase rapidly in the next few years. New mills are going up now, and additions are being made to the older mills, so that there is no question but that the industry is showing a sound and steady growth, and there is absolutely no doubt that this growth will continue.

It is well, however, to sound a word of warning to prospective pulp and paper manufacturers. No new mills should be erected whose profits are based on the present prices of pulp and paper. It seems hardly necessary to point out this fact, but, nevertheless, the high prices prevailing to-day are tempting some to consider seriously the field of pulp and paper. After the war paper prices are bound to fall, and a mill which may make a good profit to-day may find itself stranded when the lower prices come into effect. The cost of machinery, building construction and labour are so high to-day that it would probably cost nearly 100 per cent. more to erect a mill than would have been the case in 1913, for instance. Now, while this high overhead expense may be easily borne by the new mills when prices are at the abnormally high point that they have now reached, this same overhead expense would probably swamp the mills when the prices have gone back to normal. We thoroughly believe that new mills should be erected, but we also believe that under ordinary circumstances such construction should be deferred until conditions are more nearly normal.

It would hardly be right to close the article without a plea for conserving our timber

resources. We are blessed to-day with abundant forests, but at the present rate of cutting and burning we will in a few years be in the position of many other countries who began conservation of resources when the resources were almost depleted. We are fortunate in having the experience of other countries to fall back on; some of our problems are already worked out for us, and we need only to apply the solution of these problems to be assured of a supply of timber ample for all our needs.

In this connection let us consider the timber requirements of a mill manufacturing newsprint at the rate of 200 tons a day. For every ton of newspaper produced there is required about 1½ cords of wood. From an average stand of timber we can expect about 10 cords of wood to the acre, so that 30 acres per day or 9,000 acres per year are required to run a mill of this size. Now, by scientific cutting and reforestation new timber should be available for use for pulp-making in about forty years, so that a tract of from 350,000 to 400,000 acres, by careful cutting and tree planting, would suffice to run this mill indefinitely. Without proper cutting or planting this land would produce very little timber suitable for pulp purposes after it was once cut over. Canada, as a whole, is producing about 1,800 tons of newsprint alone per day, requiring about 2,700 acres per day for the production of the pulpwood used; so the importance of conserving our resources can readily be appreciated.

That the pulp and paper industry is well established in Canada may be seen from the following statistics. During the year 1915, Canadian pulp mills consumed 1,405,836 cords of wood, valued at $9,426,217, while 949,714 cords, valued at $6,164,133, were exported to the United States. Therefore, the total cut of pulpwood in Canada for 1915 was 2,355,550 cords, valued at $16,590,330. Canada is also exporting an increasingly large amount of paper every year. Paper to the value of $15,509,000 was exported in 1915, as compared with $6,327,000 in 1913 and $9,100 in 1892. While the increase in value of paper exported in 1915 over that in 1913 was due to an increase in price as well as an increase in amount, still the increase in tonnage exported is considerable. The exports to the United States for the month of May 1916 give a good idea of the nature as well as the value of the products shipped.

Exports to United States, May 1916 :—

Groundwood	$299,645
Chemical pulp	660,094
Bleached pulp	80,033
Print, book and newspaper	1,665,108
Wrapping paper	7,712

According to the best sources of information at hand, there are eighty-eight separate plants operating in Canada at the present time. These plants range from small units making a few tons of groundwood pulp per day to enormous plants manufacturing hundreds of tons of pulp and paper every twenty-four hours. The mills are distributed through Canada as follows :—

Quebec	41
Ontario	34
Nova Scotia	5
New Brunswick	4
British Columbia	4

The following table, compiled from data published by the Forestry Branch, shows the amount of pulp manufactured in Canada in 1915, and the proportion produced by each province. While the figures are not complete, since they do not include all the mills in Canada, they are valuable in that they give an idea of the size of the industry, and to what extent it is divided among the provinces :—

PULP PRODUCED IN 1915.

	Total quantity. Tons.	Per cent. distribution.
Total pulp produced ..	1,074,805	100·0
Quebec	561,793	52·3
Ontario	364,226	33·9
British Columbia ..	65,823	6·1
New Brunswick ..	62,093	5·8
Nova Scotia	20,870	1·9
Groundwood pulp produced	743,776	100·0
Quebec	425,626	57·2
Ontario	247,825	33·3
British Columbia ..	41,111	5·5
Nova Scotia	20,870	2·8
New Brunswick ..	8,334	1·1
Sulphite pulp produced	235,474	100·0
Ontario	106,401	45·2
New Brunswick ..	53,749	22·8
Quebec	50,612	21·5
British Columbia ..	24,712	10·5
Sulphate pulp produced	92,405	100·0
Quebec	82,405	89·2
Ontario	10,000	10·8
Soda pulp produced ..	3,150	100·0
Quebec	3,150	100·0

In the table which follows, a more or less rough estimate has been made of the amount of paper manufactured per twenty-four hours, and the distribution throughout the provinces. This table includes all classes of paper, such as news, wrapping, writing paper, container board, leather board, etc. :—

PAPER PRODUCED.

	Pounds paper manufactured per 24 hours.	Per cent. distribution
Total	6,752,000	100·0
Quebec	3,092,500	45·8
Ontario	3,070,000	45·5
British Columbia ..	450,000	6·6
New Brunswick ..	*100,000	1·5
Nova Scotia	40,000	0·6

* Represents potential production.

In addition to the above figures, it is estimated that developments are now under way which will, by 1918, increase the daily tonnage of pulp by 880 tons. Several mills are also increasing their capacity for producing paper, so that in the near future considerably more paper will be turned out.

When we consider the rapid growth of this industry in Canada, and the magnitude to which it has attained in a comparatively short period of time, we cannot but conclude that with our wonderful resources we are bound to become the greatest wood pulp- and paper-producing country of the world.

THE RESOURCES OF PALESTINE.

The following passage is taken from an excellent paper on "Palestine: its Resources and Suitability for Colonisation," read by E. W. G. Masterman, M.D., F.R.C.S., D.P.H., before the Royal Geographical Society, and published in the *Geographical Journal* of July, 1917:—

"So much that has been written about Palestine has been idealised by the glamour of its past that it is well to consider in sober prose what are the actual resources of a land once described as 'flowing with milk and honey.' To the traveller from the green fields of England the first impression to-day is that of a bare and half-desert land where the peasants are miserably poor: the only fruitful sites are around the villages and towns, and even these last are full of people depending for their subsistence on the wealth of tourists or the support of societies or communities in other lands. The bare limestone rocks over great areas are devoid of trees and shrubs, and even in districts to the north and north-east, where the volcanic rocks wear down to provide a richer soil, the aspect in all but springtide is often that of desolation. It seems to such as if only the glorious sunshine, the fresh breezes, and the unmatched vistas of mountain, lake, and plain—all speaking of a hundred historic associations—alone make this land of worth. And actually it is a poor land. It has no mineral wealth. No coal is to be found. What iron ore there is is not worth the working. There is neither copper, gold, nor silver. No deposits of petroleum of any size have been discovered, though in the Jordan Valley, especially at its southern end, many cherish a hope that it may occur. Deposits of bitumen are known to exist near or under the Dead Sea; small fragments may be gathered on its shores, and large masses have at times floated to its surface. In the salts of the Dead Sea small quantities of bromides and iodides occur, but hardly in quantities to allow of commercial exploitation. Beds of phosphates have been found east of the Jordan.

"But when all is said, it is upon its agriculture and its livestock that the wealth of the land must—as it has ever done—depend. It was a land of milk—that is, of abundant flocks of goats and sheep and camels—and of honey—that is, of 'dibbs,' or grape juice concentrated by boiling, the great sources of sugar in ancient time when vines were far more cultivated than to-day, as is shown by the innumerable ruined wine-presses found everywhere among the traces of long-ruined terraces. To-day grapes grow to considerable perfection and in great variety in many parts of the land, some yielding excellent wines, especially in the Jewish colonies. The vine and the fig tree, so constantly associated in the sacred writings, flourish wherever planted and cared for. Olives reach great perfection, and have undoubtedly been far more cultivated in other ages. Even now, after providing a staple food for the people, olive oil to the value of some thousands of pounds is exported annually from Jaffa. An even more important product for exportation is the sesame oil, which is produced from the late summer crop of simsim. The colocynth grows wild in the plains about Jaffa and Gaza, and also in the Jordan Valley, and the gathered crop to the value of £2,000 sterling is almost entirely exported to England. The largest export is the great orange crop from Jaffa, which much increased a few years before the war. Only a few parts of the land are suitable for this, as the gardens need abundant irrigation and the necessary conditions seem obtainable only on the sea coast. Lemons are grown also in Jaffa, and, like oranges, occur in small quantities in many sheltered and well-watered valleys. Almonds, apricots, and pomegranates all thrive in parts of the land. Melons flourish in the plains, and considerable quantities are exported from Jaffa. Tobacco can be cultivated in many parts. In the Jordan Valley bananas, American corn, rice, dates, sugar-cane and cotton all might be cultivated with profit in the better-watered areas. Wheat and barley are grown in all parts, from the mountain plateau both east and west of the Jordan to the Jordan Valley itself, where a very early and abundant harvest is obtained. The Great Plain of Esdraelon and the ancient wheat-bearing plateau of the Hauran both yield excellent crops. I have ridden through the Hauran with unbroken stretches of wheatfields extending to the horizon on every side. The railways which traverse this district from Damascus have been a heavy blow to Palestine, because the best harvests in the land are now all reaped for export, and the price of corn has risen considerably. In the drier parts of the land, particularly in the south, the harvest depends upon a very capricious rainfall, and a failure in the amount or the distribution of the season's rain may mean its entire ruin. Locusts, too, not infrequently invade the land in countless millions and eat up everything. A succession of bad seasons is a disaster, not only to the crops, but by driving the Bedouin from

their usual somewhat arid haunts into the cultivated area, where if not checked they clear the land like a swarm of locusts. Durra—Egyptian maize—is shown as a late summer crop, and thrives with little rain.

"With regard to livestock, goats are at once the most entirely suited to the land and the cause of its greatest destruction. The flocks of goats which wander at large over the hills and mountains destroy all the rising trees and shrubs, and no unenclosed district has any chance of development. At the same time they and the camels seem to flourish on a drier and scantier herbage than those accustomed to our green field could imagine possible. Fat-tailed sheep and small cattle do well in more fertile spots, finding abundant herbage in the spring. Except among the Circassians, I have never seen any attempt made to gather the tall lush herbage of the spring for hay. Buffaloes occur in the northern parts of the Jordan Valley and yield a rich milk.

"Taking Palestine as a whole, no one that knows the land can possibly call it 'desolate.' Even fertile parts may appear so to the chance stranger in midwinter, when the land has not wakened to life under the influence of the rains, or in midsummer, when life has been driven underground under the blazing heat. Also there are deserts which will probably never be of much value. Such, for example, are the eastern slopes of the Judæan Hills, where they fall rapidly towards the Jordan and the Dead Sea. The scanty rainfall produces a thin covering of scattered herbs and grass which in a very few weeks fades in all but a few valleys. The currents of air from the west, which deposit their moisture in abundance on the western side of the watershed, descend these eastern slopes as dry and scorching winds, which suck the moisture from the soil. The wild spates of water which scour these bare valleys after heavy winter rainfalls do little for the hill slopes except denude them of soil, though by filling the numerous underground cisterns constructed by the Bedouin along their course they make possible a precarious existence here for man and beast.

"Salt deserts occur also both north and south of the Dead Sea, and both south and east of Palestine the line between the 'desert and the sown' is an ever-changing one, but never far from man's settled habitations. The recent exploration of the Nejeg and the desert during the wanderings by Messrs. Newcombe and Whooley, on behalf of the Palestine Exploration Fund, has dissipated for ever the idea that these lands were ever suited for a settled agricultural community. The only time any considerable number of buildings were made there was during the Byzantine period, when great monastic establishments were founded in these wastes from religious motives, and by great diligence and the careful storage of all available water was there attained a passing appearance of prosperity.

"But there are other large areas in the land which have been 'desolated' by the neglect and devastation of centuries. Here only by patient and sustained labour can fruitfulness be extracted from the so l. There is no doubt that from early historic times—before the arrival of the Hebrews—these parts were highly cultivated; but now the devastation of centuries has reduced many to semi-desert. The destruction of the ancient terraces on the mountain sides has meant the washing away of the soil more completely than happens where the natural covering of soil, bound together by shrub and tree roots, is left undisturbed. Many hundreds of square miles of mountain slope once cultivated are now bare limestone rocks. In other places barriers across valleys, made to retain the floodwaters of spring, have long ago been swept down. A restoration of these terraces and barriers—a long and laborious work—must be a preliminary to recultivation in these regions.

"A steady deforestation has been going on for centuries, but at a greatly increased rate in recent years, when the demand for wood fuel and charcoal for European establishments, steam mills, and railways has led to an enormous destruction of trees. That the foothills and plains can easily be covered by trees is witnessed by the beautiful groups of oaks, terebinths, and pines about Carmel, Tabor, the Nazareth Hills, and Banias, and by the great forest of eucalypti planted by the Jewish settlers in the marshy lands near ancient Caesarea (Kaisariya). But on the bare mountain slopes, wherever the most sea-breezes come, pines flourish well when once they get a start. How much may be done in this direction is shown by the delightful little pine forests at El Kubeiba—traditional Emmaus—in connection with the German Roman Catholic Hospice. Here in a very few years a hilltop, previously bare and sterile, has, through the effort of one man, been converted into a charming forest. There are also many districts well suited to the cultivation of olives and figs—indeed, once so used, but now neglected and sterile.

"In the Jordan Valley there is no doubt room for considerable irrigation, both from the Jordan itself and from the tributary streams. Any scheme should consider the valley as a whole, and not in districts alone. Europeans, however, could never safely make permanent houses in the valley. Much of it is very malarious already, and great irrigation will only add to the risks from the cause; this, of course, applies with chief force to the southern parts where heat is great. Labour should be supplied by the local inhabitants, assisted by negroes; the European supervisors should make their homes

in the surrounding hills. Certainly no attempt should be made to raise children of European stock in these tropical regions. The East Jordan lands are of essential importance to Palestine, and must form part of the land if any satisfactory settlement is to be arrived at. The ancient land of Moab—now the districts of El Kerak and El Belka—are, as they have always been, excellent pasture lands of goats, sheep, and camels. The middle district, Gilead—now Djebel Adjlun—was once well wooded, and until recently an actual forest of noble trees lay on the road between the Jabbock (Wadi ez Zerka) and Es Salt. Now this is fast disappearing. This, too, is a well-watered land. Northward again, the plateaux of El Djaulan and El Nukrah (ancient Hauran) are great corn-growing districts. Much of these lofty plateaux to the east of the Jordan has a salubrious climate, and now that it is linked up by road and rail to the west and the north, a settled government only is needed for steady development to begin.

"From the reports that reach us, the only direction in which progress has occurred in Palestine during the war has been with roads and railways. The road from Jerusalem to Jericho has been extended across the Jordan to Ameman—ancient Ramoth Amman—now an important station on the Hidjaz Railway. Then a road has been carried from Akka to Safid and on to Damascus. In the south a good carriage-road from Jerusalem has been carried far south of Beersheba into the desert. The French railway line from Jaffa to Jerusalem was torn up early in the war as far inland as Ramli, and the rails utilised for the extension southward of the Palestine branch of the Hidjaz Railway. This line branches off from the Haifa-Damascus Railway at El Afuli, runs past Djenin to near Nablus, and thence past Ramli to Beersheba, if not further south. I trust that we may before long hear that it has been linked up with our railways from Egypt.

"One of the greatest problems and difficulties to agriculturists in this land is the rainfall. How far the rainfall of to-day is different from that of ancient times is an undecided question. That the land on the whole is drier and the springs scantier is certain; but this may be largely accounted for by the bare condition of the hills, whereby the rain-water passes over hard rocks straight to the valley bottoms, and thus runs away without being absorbed. Areas which have been cleared of all shrub and brushwood have become practically drier. There are also cogent reasons for believing that at certain periods in history the rainfall may have been, normally at least, as advantageously distributed as it is in the most favourable seasons at the present time. Such periods in the past have had securer and more abundant harvests, greater general fertility, and have been more favourable in every way to a settled population. At such times civilisation has crept out into places where to-day only ruined habitations can be found. It is to me almost impossible to believe that without some such cycles of change Palestine and Syria could have enjoyed the prosperity which they had, for example, in the first centuries of the present era. On the other hand, it is certain that the main features of the climate have remained the same during the whole historic period. The long summer drought and the heavy winter rains, followed by the scantier but all-important showers of the spring, must have always marked the annual cycle. The rainfall has now been studied in considerable detail for half a century. We know that the mean fall each rainy season is about 26 in. in the mountains of Judæa, and that nearly all this falls during December to March, though the earlier and the later showers are also all-important to a successful season. Unfortunately the seasonal rainfall is liable to great fluctuation in amount and distribution. If the 'later rain' fails the harvest may—especially in the mountains, where the harvest is late—be ruined. We see this occur at times to-day as it did many centuries ago. The hot *shurkiya* (the sirocco), which makes the autumn and late spring months so trying to Europeans, may delay the ingathering of the harvest dangerously late, as the dry and brittle grain cannot be gathered in without great loss.

"For European settlers the long spells of summer heat—90° to 100° F. or more days at a time—must be a serious consideration. Although such temperatures occur in the highest mountain districts, and sunstroke is by no means uncommon, the heat is largely mitigated by cool night breezes; in the lower lands the effect of this continuous heat is much more dangerous. It may be seriously questioned whether a continuance of such conditions may not in time—in a few generations at least—lead to a physical degeneration and loss of stamina. We, at least, may ask ourselves what has been the effect of these conditions upon the great numbers of Europeans who in the past centuries have been domiciled in these lands. Have they died out? Or has the stock lost its virile Northern qualities and become assimilated to the people of the land? I am convinced that only the higher parts of Palestine are suited to those who for many generations have been accustomed to the more Northern climes, and even these must lead a life in which consideration for climatic conditions must bear a large part."

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Aeroplane Cloths.—It has been officially said that in pursuit of its war programme the Government is supplying the seed to grow the flax needed for the wings of its aeroplanes. Cotton is not unserviceable for the purpose, but the preference for the scarcer linen is marked, and

does not arise solely out of a desire to utilise home-grown material. Cost can have very little to do with the matter, as the difference in price between one fabric and another is the merest trifle in the total cost of a well-found aeroplane. The evident advantage possessed by linen is that of strength, traceable chiefly to the much greater length of the individual fibre. Weight for weight, linen is decidedly the stronger of the two, and it can be woven into cloth of a suitable lightness of, say, 4 oz. per square yard. Lightness is an important element in all accessories of aviation, and before being flown the fabric is made heavier. The sails are painted with the mixture known to airmen as dope, which should have the effect of strengthening and tautening them. A too heavy or too open canvas requires too much dope, and as the dressing costs about as much as the fabric, and is a recurrent item of expense, its consumption should not be increased without good reason. Cotton and linen contract after doping, but it is reported that ramie does not. Ramie is not readily obtainable in light-weight cloth, and although its strength across the wings is extraordinary, it is brittle and weak at the joinings.

Some Discontents.—There have been marked exhibitions of industrial unrest in the wool trade, notably among dealers and spinners, who have revolted against the regulations drawn up for the control of their operations. The grievances against the allocation of supplies and the restrictions upon working hours are receiving attentive consideration, and are possibly susceptible of relief. These are caused by contrary notions of prudence entertained on the one hand by civil servants and on the other by business men. Unrest, either amongst workpeople or employers, is usually due to a combination of causes, actual or imagined, and fact and fiction are not readily disentangled in a state of general irritation. Certainly some ill odour is due to involuntary favouritism. It must always be an invidious thing to single out certain dealers from the mass and appoint them sole dealers in certain lines of goods. Other dealers may sell to the selected few, or be affiliated with them for purposes of organisation, so that the unauthorised man is not inevitably brought to a standstill. In those circumstances the authorised dealer acquires for the time being the goodwill of his rival's business, supervises his affairs, learns his sources of supply and methods of trading, and takes over his customers. The arrangement is, of course, strictly temporary, but its effects can never be expunged, and the real reason for some savage feeling is that, at the dictates of controllers, the patient labour of years has had to be given away when, by following some other course, the property in commercial connections might perhaps have been preserved.

The Cotton Market.—The Cotton Control Board abstains for the present from drastic new interferences with established custom, bending its energies towards keeping the industry supplied from hand to mouth. Even so it does not escape severe criticism coming from opposing points of view. The futures cotton market is meanwhile closed, and should that condition last long enough the cotton trade will have a chance of forming a new opinion of its advantage to traders. The subject is excessively intricate, and although theory is rather favourable to the maintenance of unlimited dealings, the sense of a good many spinners is against paper operations. This contrariety of views is not peculiar to Lancashire or to the cotton market, but is matched elsewhere; and if the truth can be established, whether in one sense or another, without dire loss the closing of the market will not have occurred in vain.

Foreign Dyestuffs.—It may be noted that an important amalgamation of coal-tar colour, intermediate and raw material manufacturing concerns has been brought about in the United States. The new National Aniline and Chemical Co., New York, unites the Schoellkopf, Beckers, National and Benzol Products companies, and acquires certain properties of the General Chemical Co., the Barrett Co., and Semet-Solvay Co. The Dupont de Nemours Co., which made a profit of £11,000,000 from munitions in its last year, is outside, as are some other fairly considerable works. The line of development, however, is precisely that which has been unceasingly advocated for British firms by the principal consumers of dyestuffs, and its adoption in America, following upon the recombination in Germany, should not be ignored. New concerns for the manufacture of colour are coming into life in America in quick succession.

Evaluation of Warmth.—It is a simple enough proposition that goods which are bought for warmth should be tested for their power of retaining heat, but it appears that little has been scientifically done with that object. Some experiments conducted at the Massachusetts School of Technology at least suggest a method, although no high value can be set upon the particular conclusions reached. Professors G. B. Haven and G. W. Swett designed their own apparatus, using electrical resistance coils to maintain at blood-heat the water in a thin copper cylinder protected with insulating material at its ends. Round this tube they wrapped three folds of the specimen blanket under test, taking elementary precautions to secure even tension. To stimulate radiation the apparatus was set up in a refrigerated chamber, and the loss of heat was registered by records of the amount of energy consumed in maintaining a constant level of temperature in

the water. The experiments were made at the instance of a manufacturer of cotton blankets to compare certain of his goods with others regarded as average woollen ones. The experimenters found, of course, a relation between the thickness of the fabric and its power of retarding radiation, and they measured the thickness of their specimens with special instruments. Blankets being sold by weight, there is perhaps more to be said for relating the results to weight than to area and thickness, although all three dimensions are to the point. Evidently the nature of a blanket is not indicated with any exactitude by the name of the fibre from which it is made, for there are wide differences between either wools or cottons and between manufacturing methods. Fibres which, in a compact state, are poor non-conductors are, by a suitably loose arrangement of their positions, made into warm clothing, and conceivably there is something to be learnt from an exact statement of results obtained from materials of given quality treated in a specified way. It would be interesting, for instance, to know how goods made from fine and coarse fibres compare. To make the results of a comparison between wool blankets and cotton ones thoroughly useful, it would be advisable to follow the fabrics through their wear and washings, for it by no means follows that the article that is efficient in its first state retains its virtue for long under the regular conditions of use

NOTES ON BOOKS.

Electric Traction. By A. T. Dover. London: Whittaker & Co. 18s. net.

As a wartime production this book does much credit to the publishers. The paper is good, and the very numerous photographic reproductions of plant and apparatus and diagrams are excellent—so good that they bear the use of a hand magnifier well, and a great deal of extra detail and improvement in the natural effect of the illustrations can be obtained in this way, and we should strongly recommend the student to adopt it.

The writer has been well advised to make free use of the engineering catalogues and pamphlets which manufacturers so frequently issue nowadays, for they often attain a high standard of excellence, and are prepared by people who know what is wanted and how to get the best results. In these respects the work is a good compendium of much of the best engineering practice of the day relating to tramway and railway electric engineering.

The book deals only with the track, the overhead arrangements, the motors and trucks, controlling apparatus, sub-stations, and distributing systems. Even with these limitations, and confining the examples to English and American, with some notice of Swiss and Italian railway work, there is little room for comparative consideration of alternate methods, although the letterpress descriptions are terse and clear. The fact is that there is such an immense amount of detail and variety in the different classes of this kind of work, that the practical engineer, after getting a general idea of the whole from such a work as this, finds that he has to confine himself to the particular variety with which he has to deal personally, and he will even then have as much reading as most men care for to keep in the forefront of knowledge of his own particular department. This is particularly true where comparative and judicial knowledge is necessary, as is especially the case in such work as we are considering.

It is, of course, very desirable that the student should have a good idea of the engineering principles on which tramway and railway work are founded; these are tersely and clearly described in the book, and can be readily followed practically with the help of the illustrations. The author also gives references to a number of leading original papers dealing with various branches of the subject, and the student is strongly advised to look up as many of these as he can find access to, as here he will find the subject treated with a certain tone which is rather regrettably absent from the book itself, possibly from want of room, and also because the author's profession is that of a teacher, and he therefore approaches the subject rather from the descriptive point of view than as one who has got to exercise a critical judgment on what he describes.

It is, of course, desirable that young engineers should understand and be able to describe the plant they are to operate, but it is of equal importance that they should be trained to criticise, discriminate, and exercise judgment on its design and working, as nine out of ten engineers will ultimately be in positions where the plant is already in existence, where it is no longer a question of the ideally best plant, but where the best must be made of arrangements already existing, with such detailed improvements as can be effected from time to time, without departing from the original lines on which the work was laid out.

The book does not touch the questions of capital cost or cost of operation, either actually or comparatively, as compared with other means of effecting the same ends which exist in most cases—questions which occupy so much of the time of the practical tramway engineer. It is no demerit in the work under review that these questions are not treated, but in a book entitled simply "Electric Traction," and therefore presumably dealing with the whole subject, such very important aspects need reference, to give the student a proper perspective, even if he must look elsewhere for an adequate statement of problems which will haunt him the moment he passes from the college to the staff of some tramway or railway company.

GENERAL NOTES.

THE QUEEN'S HOSPITAL.—An appeal is issued for donations in support of this new hospital and training school, established (with the gracious approval of Her Majesty the Queen, and with the consent of the Directors General of the Navy and Army Medical Services) at Frognal, Sidcup, Kent, for the treatment of sailors and soldiers suffering from facial and jaw injuries. This model institution, with its plastic and dental operating theatres, erected and equipped on the most scientific principles, will fulfil a great need. The chief among its objects is to remove acute cases of facial and jaw injuries from the atmosphere of crowded hospitals into fresh country air and delightful surroundings, and so give these terrible wounds every chance to heal more rapidly after the frequent operations which are necessary; also to provide cheerful outdoor occupation for the men, who frequently have to remain under treatment for eighteen months to two years, and who suffer so acutely from mental depression. Many of the cases are beyond description. Liberal grants have been made by the British Red Cross Society and Order of St. John and the National Relief Fund towards the cost of building, but a large sum is still required to complete and equip the hospital and workshops, and to provide for their upkeep. Donations should be sent addressed to C. H. Kenderdine, Esq., Hon. Secretary and Treasurer, St. Stephen's House, Westminster, S.W. (1), marked "The Queen's Hospital."

AERIAL POSTAL SERVICE BETWEEN ITALY, SICILY, AND SARDINIA.—A regular postal service by the air route has just been established between continental Italy and the islands of Sicily and Sardinia. The first was inaugurated on June 24th between Naples and Palermo, and the other from Civita Vecchia, on the mainland, to Terranuova-Pausania (Sardinia), three days later. The first trip from Naples to Palermo was made by a seaplane, at a speed of 140 kilometres per hour (87 English miles), flying at an altitude of 1,500 metres to 2,000 metres (5,000 and 6,000 feet) above sea level, which reached Palermo in less than 2½ hours. A heavy mail, consisting of letters and newspapers from all parts of Italy, directed to all the principal towns in the island, was carried. The machine was manned by a pilot and a motor driver. The service from Civita Vecchia to Sardinia was successfully opened on June 27th by two seaplanes, each carrying 100 kilogs (about 2 cwt.) of mail in watertight bags. The crew of each machine consisted of a pilot and a motor driver. Leaving Civita Vecchia within a few minutes of each other at 6.20 a.m., they reached Terranuova about 8 a.m., the journey having occupied 1 hour 40 minutes. The trip back was made by a single machine, which started ten minutes after the arrival of the two others, and landed at Civita Vecchia at 9.50 a.m., having occupied the same time as before.

ARTIFICIAL LAKES AND FISH SUPPLIES.—Mr. A. D. Ferguson, of the California Fish and Game Commission, writing in *California Fish and Game* (Vol. III. No. 2), describes the steps which have been taken to stock with fish the large artificial lakes formed by the great dams in the Sierra Nevada Mountains. By the building of the Crane Valley dam the Bass Lake was created, a sheet of water six miles long, half a mile wide, and 100 ft. deep. This is now teeming with trout and black bass, artificially introduced. Huntingdon Lake, in Fresno county, was similarly created by a dam 120 ft. in height, impounding 150,000 acres of water. This has been stocked with rainbow and Loch Leven trout, and is frequented by thousands of anglers from all parts of the State. The primary purpose of the dam was to serve as a generating station for the Pacific Light and Power Corporation. In this way, says *Nature*, in commenting on the work, purely commercial ventures have been made to add both to the natural beauties of the country and to its productiveness.

ELECTROLYTIC ZINC WORKS IN TASMANIA.—An Australian company has been formed, known as the Amalgamated Zinc (De Bevay's), Ltd., with a capital of £1,000,000, for the production of zinc by the electrolytic process, and for manufacturing high-grade spelter in Tasmania. Arrangements have been made, according to the *Board of Trade Journal*, to lease about 77 acres of Crown land at Risdon, on the River Derwent, as a site for the works. A new jetty and ferry terminus will be constructed close to the site. The State Hydro-Electric Department has undertaken to supply the Company with power aggregating 50,000 h.p. from the Department's Great Lake plant, of which not more than 40,000 h.p. is to be utilised in the production of electrolytic zinc; the remaining 10,000 h.p. is to be used in the manufacture of other electrochemical or electro-metallurgical products.

RUBBER IN MALAYA.—Some remarkable figures showing the rapid growth of the rubber industry in Malaya are given in the *Bulletin Économique de l'Indo-Chine*. In 1906 the amount of rubber grown in Malaya was only 430 tons, valued at £240,800. These figures rose steadily until, in 1915, the amount had become 68,500 tons, and the value £19,180,000. Formerly the principal source of wealth of Malaya was tin, with an export worth on the average £7,613,000; but the value of the rubber plantations is now more than double that figure, and is still rapidly increasing.

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AIRCRAFT AND MOTOR-CAR ENGINE DESIGN: CONTRASTED FROM THE STANDPOINT OF A DESIGNER AND MANUFACTURER OF BOTH TYPES.*

By LOUIS COATALEN.

That belief which appears to obtain in some quarters to the effect that the design and production of an aircraft engine is akin to that of a motor-car one proves, on even casual investigation, to be what the old writers would have styled a vulgar error. By taking a few points which come most obviously to mind, we discover at the very outset that the problems involved by the two propositions are fundamentally different.

CHIEF CHARACTERISTICS OF A CAR ENGINE—

Consider for a moment the chief characteristics of an internal-combustion engine for motor-car service :—

1. Weight is practically no object.

2. Cost is of the utmost importance; therefore there must be the minimum of machinery—as instance the fact that the connecting rods of a motor-car engine are not milled, nor are the crankshafts machined all over.

3. It must be capable of production in great quantities at minimum cost; otherwise, with the least amount of labour.

4. It must be silent to the extreme of what is practicable.

5. The maximum effort of which the engine is capable is not needed to be maintained for long at a spell. It seldom works at full power, and the brief duration of such effort explains the extraordinary reliability of even the inferior types of car engines.

6. Flexibility, giving a constant torque at a crankshaft speed from 300 revolutions a minute to 2,000 revolutions a minute.

7. Of course, this is a torque which corresponds to a very low mean effective pressure, namely, 80 lb.

8. The compression is relatively low and the valve area small, the cam forms being easy and the valve springs light.

9. The system of lubrication, wherein the oil is carried in the base-chamber of the crank case, suffices.

10. The maximum horse-power required to be developed by any one engine rarely approaches 100. In the vast majority of cases it does not exceed 30.

—AND ONE FOR AIRCRAFT SERVICE.

By contrast, the factors governing the design of an aircraft engine may be enumerated thus :—

1. Weight is of prime importance.

2. Cost is not the deciding factor provided the necessary amount of power is obtained for the given over-all dimensions of the engine, for its weight both as regards material and fuel, water and lubricant consumption, and that the desired degree of reliability is obtained.

3. The amount of labour necessary to produce a satisfactory aircraft engine of high output is, and will be, always many times what is necessary in the case of a car engine, and is a matter of secondary importance provided the desired results are obtained. No machining is too expensive if it saves weight.

4. Silence is relatively unimportant.

5. The aircraft engine does all its work at practically full power.

6. Flexibility, or evenness of torque, is of very secondary importance, because an aircraft engine is required to develop maximum torque at practically one speed only, or, at most, at an extremely narrow range of speed.

7. But at its working range of speeds a very high brake mean effective pressure is called for.

8. The compression must be relatively high and the valve area large, while the valve springs

* Extracted from a paper read before the Aeronautical Society of Great Britain on May 16th, 1917.

must be stronger than for a motor-car, owing to the cam form imposed.

9. The high mean effective pressure necessary, coupled with the fact of the engine doing nearly all its work at full power, involves a completely different point of departure in determining details of design and, notably, the exploitation of new methods of achieving lubrication. Experience has demonstrated abundantly that when the base-chamber is used as an oil well, as in motor-car practice, the lubricant soon becomes too hot, therefore too fluid, resulting in reduction of pressure to the main bearings; hence the evolution of the dry sump system for lubricating aircraft engines. Oil viscosity varies greatly with the temperature.

Evolution of the Dry Sump Lubricating System.

I would mention in passing that the history of the engine dry base lubricating system is neither more nor less than the story of my racing experience on the Brooklands track. In the course of long runs on it years ago, it was found that the oil pressure went down more and more the longer each run was continued. Naturally we tried one brand of oil after another with the view to discovering which would retain its viscosity most effectively. Of course, castor oil gave greatly superior results to mineral oils. Even so, however, it soon became plain that the problem was one that could not be solved entirely by the use of a vegetable oil. Indeed, results were quite unsatisfactory, notwithstanding that we greatly increased the effectiveness of the pump employed. Therefore my next step was to use the same pump to force the oil out of the base-chamber through two 1-in. copper pipes arranged round the car. We returned the oil direct from that process of cooling to the service of the bearings under pressure. This proved a great advance as regards maintaining pressure; but the scheme involved all the inconvenience of a long circuit for the oil in connection with which all the cooling was achieved under pressure, because the oil passed quite round the car before being returned to the bearings.

Therefore the next stage was to employ two pumps. One forced the oil out of the base-chamber through a cooler, from which it passed into a tank placed at the back of the car. In this tank the oil was not under pressure of the pump, for the tank itself was merely under atmospheric pressure. In practice it was found that this was really a notable improvement. Thus the bulk of the oil was kept all the time in the tank, which itself was in a draught while the car was travelling, while the base-chamber itself was kept quite empty. From the tank the oil passed to the pump, and was so forced by it into the bearings. Therefore the oil was under pressure only for a short distance, namely, from the pump to the bearings, because, as has been explained already, the tank itself was under atmospheric pressure.

Only when we had arrived at this stage was it found that racing cars with engines of high output could be run for more or less indefinite periods without the temperature of the lubricating oil attaining more than 66 degrees Centigrade, at which warmth a very good working viscosity was retained.

10. Lastly, in contrasting the standard car engine, the racing-car engine, and the aircraft engine propositions under the headings that have been selected for the sake of illustration, it is to be noted that the total amount of horsepower required to be developed by practically all aircraft engines to-day is about 100 minimum, while the maximum totals several hundred horse-power per unit.

Two Distinct Propositions.

It will be seen from those ten points of contrast, which, doubtless, might be increased in number, that the aircraft engine of to-day is not akin to the standard motor-car one. Admittedly, the twain are collaterals, both deriving from a common stock, the four-stroke-cycle petrol internal-combustion engine. For the rest, the aircraft engine of to-day is, perhaps, as little like the standard motor-car one as that resembles the variety used on a commercial motor vehicle or that installed in a motor-boat. In fine, it may be said that, as the stationary gas-engine resembles the portable petrol variety to that meagre degree, and scarcely more, does the motor-car engine resemble the aircraft type. It cannot be proved that the aircraft engine has been developed from the touring-car variety. On the contrary, it can be demonstrated abundantly that the aircraft engine is quite a distinct branch of the development of the internal-combustion engine. Hence many firms that have been strikingly successful in producing car engines for either touring or commercial use have experienced great and, in some cases, unsurmounted difficulty when called upon to change over to the manufacture of power plant for aircraft. The differences apparent in the design become even more pronounced when they

are translated into manufacturing problems in the shops.

On the other hand, we may not lose sight of the likelihood that the very rapid evolution of the aircraft engine during this war, and the extraordinary manufacturing experience and developments of which that is the outcome, will at some future time exercise a more or less temporary effect on the design and manufacture of engines for car service.

Be this as may be, in broad terms I am of opinion that the two schools of design, one concerned with each of these problems, will continue to advance for the most part along two distinct lines which will rather become more than less divergent. Hence on the present occasion little further attention need be devoted to standard engine design for car practice. Suffice it to observe that to date the non-technical opinion of the buying public, which opinion is not to be depreciated altogether, has exercised a not inconsiderable and, on occasion, detrimental influence on the designer and manufacturer. It will be observed, incidentally, that the element affects the proposition of aircraft engine design scarcely at all, especially under the conditions which are beginning to govern the industry towards the conclusion of the third year of war.

The Analogy of the Racing-car Engine.

By contrast, there is another type of engine specially built, as distinct from standardised, which is fitted to a few motor chassis only each year in relation to the total number produced, because it is evolved and employed for racing purposes solely. Admittedly, in the beginnings of the motor industry the racing car of one year became the standard vehicle the succeeding season. With the lapse of time, however, racing became so highly specialised that if the individual competitor was to enjoy any prospect of success during the last four or five years the racing engine had become a proposition utterly distinct from those standardised for service or ordinary civilian motor vehicle uses. This point is proved by a summary of the main characteristics required of a racing-car engine, and which we find are to a considerable extent identical with those needed for an aviation engine. Thus:—

1. Weight is of importance.
2. Cost is unimportant.
3. The amount of labour and the time necessary for production are matters of relative indifference provided the maximum output of horse-power is obtained for a given size of engine. That demand has led manufacturers to employ overhead valves, which are also used in aviation service, and which so far have been employed comparatively little in standard car practice, partly on account of the principle not being so quiet in operation as the side-valve system. Every part of a racing-car engine must be machined. The connecting rods are milled to the minimum section, and so forth.
4. Silence is of no importance whatever.
5. The racing-car engine does all its work at practically full power, but the evenness of its torque has to be extended over very much wider ranges of speed than is needed so far in the case of an aircraft engine. From 1,600 to 3,400 crankshaft revolutions a minute is called for in the former case, whereas in the latter the normal speed is 2,100. The last-named figure chances to be no less than 1,300 revolutions a minute slower than the capacity of Sunbeam racing-car engines. Therefore it will be appreciated that the engine for racing-car service is submitted to bigger stresses than the present-day aviation engine, but that this period of high stress in the case of the vehicle variety is much shorter than obtains in that of the aviation type unless, indeed, the car is being run on a track. Even in that event twelve consecutive hours is considered a very long spell, whereas in aircraft service that period of uninterrupted power output is held to be all in the day's work.
6. Under the heading of flexibility the engine for your racing car must be more akin to standard car requirements than to those of aircraft service. This characteristic, therefore, works out as a disadvantage to the racing-car engine. When employed on dry roads with efficient gears and so forth the starting torque mounts up to a high figure, whereas in the aircraft engine at starting there is no load on the propeller. It increases, roughly, with the cube of the revolutions.
7. The racing-car engine resembles the aviation type in that a very high mean effective pressure has to be obtained with both. In some racing-car engines it has amounted to 135 lb. to the square inch, taken from the brake horse-power developed at the flywheel.
8. As the problem is power for engine weight and volume, and not silence and low cost, great freedom is allowed the racing-car engine designer as regards piston clearances, valve timing, compression, largeness of valve area, strength of valve springs, and so forth, the opportunities in

this connection approximating much more to aviation than to standard car engine practice.

9. The high mean effective pressure necessary, coupled with the fact of nearly all the work being done at full power, calls for lubrication methods quite distinct from standard car practice, albeit as yet these have rarely approximated to that of aircraft engine practice, though the problems of maintaining pressure in the oil circuit and of keeping the temperature of the lubricant normal are common to racing and aviation engine service.

10. Comparatively large horse-power is needed in the case of all engines for racing cars, the average being anything from 80 to 225 horse-power; therefore much more on a plane with the demands for aircraft service than with those for the touring car, the town carriage, or the utility motor vehicle.

Lastly, outside influence, traceable in the cases of designing the private car engine and the commercial motor vehicle one, is scarcely, if at all, to be detected in those of the racing-car engine and of the aircraft variety. The racing-car type has been developed with almost amazing rapidity through various stages along the lines of maximum power combined with low, as distinct from minimum, weight, and with the utmost reliability, notably with a view to enabling the machine to be run for long spells without loss of power.

We might, perhaps, complete our survey of the inter-relationship of these three branches of motor engineering enterprise by adding that in the aircraft engine we have to economise weight considerably over the degree that will suffice for racing-car practice, while economy of fuel and oil consumption are also more important in the case of the former than of the latter. Admittedly, in the racing-car engine those two features constitute a special and important factor, but not one that has had to be studied yet on entirely different lines from standard car practice. Accordingly, perhaps we might conclude not unreasonably by stating in general terms that one stage in the development of the aircraft engine is represented by racing-car enterprise as well as, perhaps, by certain sporting motor-boat engine work. Endeavours in these directions provided us with the data from which were designed the first engines evolved on lines to be of such efficiency as the present-day aircraft variety.

In face of our being now in the third year of war, and therefore for the most part somewhat out of practice in the matter of racing-car engine design, whereas the leading firms in the industry in Europe have by now accumulated much experience of standardising aircraft engines, though of recent years none of them have ever standardised any for racing service, it may be said that the data on which aircraft engines are being designed to-day derive wholly from cumulative experience of aircraft engines, and have ceased to depend in any way on racing-car experience.

Indeed, on the coming of peace, doubtless it will be found that the position has been wholly reversed from that which obtained before the war. In the future not a little of racing-car engine design may derive from aircraft engine practice.

Desiderata in Aircraft Engine Design.

To approach the problem from the correct point of view, we must recognise that the outstanding desiderata in designing aircraft engines to-day may be summarised thus:—

(a) Light weight, combined with low fuel and oil consumption, per horse-power.

(b) Reliability.

If we can but attain those characteristics with units of not less than, say, 200 h.p.—better still, if we can exploit them in units each up to 600 h.p.—then we can afford more or less to neglect other desiderata as being of minor importance. Nevertheless, happily we can already go a far way towards realising what we might style the minor desiderata, which at this period of the war include:—

(a) Simplification to the utmost in face of these engines being placed, for the most part, in the hands of a great number of men semi-skilled in even flying and maintaining them.

(b) Foolproof as much as possible in that some of the most daring Service fliers have not either the temperament or the understanding to spare the engines of which they are put in charge.

(c) Accessibility in face of the frequent attention needed by all aircraft engines, and of the fortunes of war rendering it necessary on occasion to replace the most vital parts.

(d) Standardisation, because for the first time in the story of motor engineering we are making engines of high output in series in place of about a half-dozen examples at a time.

(e) Suitability of exterior form, that the power plant may be accommodated conveniently in the aircraft and occasion the minimum displacement.

Influences on the Aircraft Constructor of the Particular Employment.

Thus there are strict limits to the diametrical size of radial engines, whether of the rotary or of the stationary type, which it is profitable to employ for aircraft work; while in regard to the vertical or to the V-type engines, the nature of the particular service to which each individual engine is to be put likewise imposes certain limits. In certain cases strict limits must be set to over-all length of the engine, particularly at a time of war in the air, when, at need, it is essential to lose the minimum time in altering the flight path of the machine from a diving attitude to a very steep climbing one. Again, some sorts of aircraft call for the minimum engine head resistance, but are less imperative as to over-all length; hence the six-cylinder type would be suitable for such service, whereas the V-type variety would not be.

Uniformity of Certain Characteristics.

In other words, at this period it is impossible to lay down any arbitrary rules as to any one type of aircraft engine being suitable for the needs of all aircraft service. Those needs are almost as various as are the demands for special varieties of steel and of alloys. Moreover, they are likely to multiply with the lapse of time. Yet between the widest varieties we perceive the essential characteristics of demand to be uniform. This is a great gain alike to the designer and to the manufacturer on the one hand and to the Services on the other. It means that, when the right scheme of design is evolved, the least possible disturbance is caused in the given factory, though it be concerned with producing power plant of various size, weight, and horse-power output. Therefore the maximum production can be attained while the problems of management and repair are correspondingly reduced to the minimum. Interchangeability can be exploited to the maximum, and, once the mechanics and pilots have mastered the principles of whatever system of construction is in question, it is found that those principles are applicable to all varieties of the given system of construction.

Demand in a State of Flux.

When we come to systems of construction, again there can be no laying down of hard-and-fast rules, for the sufficient reason that the suitability or otherwise of systems is predetermined by the demands of the aircraft constructor and the aircraft user, which demands are ever varying. Therefore what system may be the most suitable thing possible to attain satisfaction of the demand of to-day is not necessarily the principle on which to work for satisfying the demand of next year, or of five years hence. Thus, while we may make bold to criticise the suitability of this system or that to satisfy the insistent demand of the hour, we must have a care not to be drawn into the making of sweeping assertions about the practicability of any system of construction for the necessarily nebulous needs of the future.

Difference Between Might Be and Must.

Probably it is little realised that if the aircraft engine designer had not to think of the means at present available to the manufacturer, nor of the time factor, nor of those to whose tender mercies the standardised product will be submitted, he would produce very different designs to fulfil any given purpose from those he evolves to-day.

Aircraft engine design resembles motor-car engine production in this particular, that it is all the time a question of compromise. The most successful designer is he who exercises the soundest judgment in weighing a hundred-and-one factors of the hour, and who gives the shrewdest estimate of the relative value of each.

Having thus striven to give a notion of what one might style the psychology of aircraft engine designing at this or any period, let us take some of the governing factors of to-day somewhat more in detail. It is not deemed desirable, therefore it is not proposed, to give in a paper of this sort particulars of any engines such as are being or are about to be used by the Services in this war. Instead, it is held to be preferable to review with more or less detail the points that have received most attention in the development of the design of the latter-day aircraft engine.

The Three Main Schemes.

In regard to the general arrangement of aircraft engines, there are several main types each of which involves advantages as well as disadvantages. The business of the designer is to effect the best compromise possible to fulfil the particular class of service that is had in mind in scheming the individual engine.

Of course, multi-cylinders are common to all types of aircraft engines. But the arrangement of the cylinder groupings and settings differs entirely as between one type and another. Doubtless the most generally favoured form is

the V type with either twelve or eight cylinders per unit, these being set in two rows on a common crankcase, whereby one crankshaft suffices because one crankpin serves for each pair of opposed cylinders.

Undoubtedly next in order of importance is the radial type, in which the cylinders are set in one or more planes with axes radiating from the centre line of the crankshaft.

The two sub-divisions of the radial type of engine are the rotating and the fixed variety.

What we may style the straight-line engine constitutes the third main type. In this four, more generally six, and, in a few examples, even eight cylinders and twelve, are placed in a line and are set vertically on a crankcase, the pistons and connecting rods acting on a crankshaft with one crankpin per cylinder in the orthodox fashion of motor-car engine practice.

The Sphere of Utility of each Type.

Inasmuch as each of these three types has advantages peculiar to itself, it follows that each is the most suitable so far available for some particular form of aircraft. For instance, the cross-section or wind-resistance area per horse-power is least in the straight-line engine and most in the rotating radial type. This includes the loss of power necessary to rotate the engine. The fore and aft length of the engine, however, which is of great importance in some aircraft, is least per horse-power in the case of the rotating radial type and greatest per horse-power in the straight-line engine. Moreover, when the straight-line engine is water-cooled, as is generally the case, the rotating radial type gains a further advantage on the score of decreased weight per horse-power. Against this, however, the economy of fuel and oil consumption which can be obtained with the straight-line water-cooled engine is appreciably greater than is possible with the rotating air-cooled type as designed to-day.

Somewhere between the two contrasted types of engines as regards the problems of wind resistance and over-all length is what is styled the V type of motor, wherein weight per horse-power is lighter than in the straight-line engine, owing, of course, to the proportionately much greater crankshaft size in relation to the number of cylinders employed. But if we consider the case of the air-cooled V-type engine under the score of weight per horse-power, of course, it has to yield place to the rotating radial type.

Unusual Types.

Yet another type which I have produced and standardised during the past year with highly satisfactory results is a development of the V form of engine, in which more than two rows of cylinders are placed on a common crankcase. The particular engine in mind employs three rows, each of six cylinders, on a common crankcase, each crankpin being connected to three pistons by articulated rods. In this eighteen-cylinder unit the centre lines of the cylinder make, in relation each to the other, an angle of 40 degrees. This allows of a very good firing diagram. This type of engine is one that is considered very promising for units of very large power. As regards weight per horse-power, it has advantages over both the V and the straight-line types of engines.

A further development of this design, in which the rows of cylinders are increased, brings us to the consideration of the fixed radial engine, which, in my mind, is one that has been sadly neglected. I feel that we shall hear a deal more about it in the near future. Several forms of these engines have been designed and made, but it may be said, in broad terms, that the success of them does not yet appear to be as great as we should be led to anticipate from consideration of the possibilities of this particular form of design.

The question of head resistance might be raised in regard to this engine, in that, when many cylinders are used, the diameter of the projected area of the power plant is increased.

Suitability of Fuselage Section.

In the case of most single-engined aeroplanes or seaplanes a fuselage of circular cross-section is admirable. It can be made large enough to accommodate the fixed radial type engine without increasing unduly the head resistance of the machine.

This is not so, however, in the case of multi-engined aircraft, in which the power plant units are placed away from the body of the machine. In these cases increase of head resistance above the minimum necessary for each power unit is the greatest disadvantage; therefore its avoidance is of vital importance. Hence for multi-cylinder aircraft the straight-line type of engine is the more suitable, particularly as the power per unit at present demanded by the builders of these machines is well within the compass of types that have been produced on the principle wherein the cylinders employed are set in a single row vertically on the crankcase.

In the circumstances in which we meet in mid-campaign it is not possible to discuss definitely the size of engine which is most likely to be adopted as standard in the near future.

Influence of Service Experience in Modifying Design.

A particular effect of the war on the evolution of aviation is the rapidity of the advance which has been and which continues to be made in the design and production both of aircraft and of engines for them. Compared with the average of enterprise in normal times, the amount of experiment that has been carried out in these directions during the last year or two is amazing, and the practical results obtained are correspondingly important. In the Sunbeam factor experimental work is held to be of vital importance, in that the discovery of anything that gives advantage over any feature of previous practice is essential for the improvement of the product standardised. Doubtless this accounts for the rapidity with which changes are made in details of design, also for the fact that the whole question of design is vastly more in a state of flux than the lay mind imagines.

Further, the experience gained by our aviators since the beginning of the war, together with the demand for the engineer to meet their ever-growing needs, have called for continuous evolution in the design of aircraft, all of which has inspired corresponding enterprise in regard to engine construction and production.

The Problem of Weight.

With regard to the question of weight, the purpose for which the particular aircraft is required is of prime importance. Obviously, in the case of the engine in a machine designed for short flights only, the consumption of fuel and of lubricant is of less importance than the weight of the engine itself, whereas in the case of the heavier sorts of aircraft with which flights of long duration are obtained and for which great power per engine is needed the consumption assumes much more importance than the actual weight of the engine. In these latter cases efficiency as regards the weight of the power unit has to be arrived at by taking the weight of the engine complete with the amount of fuel and oil that would be consumed in the course of a flight of, say, five or six hours' duration. Thus for short flights the rotary type of engine generally and the air-cooled varieties are apt to show up to advantage, though in them consumption may be comparatively high, because this is offset by the relative lightness of their starting weight.

From several papers that have been read recently with reference to aircraft engines, it is evident that, speaking broadly, as regards weight per horse-power, progress in the design of the ordinary water-cooled type is very marked.

It follows that in designing aircraft engines a variety of points have to be considered with extreme care concerning which the builder of an engine for ordinary car service is not forced to take much trouble. This difference is rendered necessary, firstly, by reason of the amount of material employed, and, secondly, on account of the comparatively light weight of the aircraft engine complete.

Valve Design: The Intermediate Stage.

The design of the engine head, the cylinders, the valves, and the valve gear is one of the cardinal features of successful aircraft engine production. Car engine design allows of the employment of the L-shaped head, or, in some cases, even of the T-shaped type, though the latter is not used to any great extent to-day for automobile vehicle practice. Undoubtedly the L-shaped head has given excellent results in aircraft engine practice in the past; but I prefer to consider that such examples really represent an intermediate stage in evolution, and that they stand rather for modified or adapted car engine design than for aircraft engine design proper. In point of fact, high efficiency is got with this type of head only by the use of a special design of valve cap that makes provision for the maximum surface of the engine head being served with water by the cooling system. In other words, you employ a form of duplicated valve cap, the removal of the upper and outer member of which reveals a space for water to circulate beneath it when the engine is working. At the bottom of that water is the valve cap proper. Further, to get the best results, it is needful to machine as much of the surface of this transition type of engine as possible.

The Number of Valves per Cylinder.

For standard car work one exhaust and one inlet valve per cylinder have sufficed for general practice to date, whereas present-day demands on aircraft engine designers are so great that any attempt to attain the requisite degree of efficiency by further exploiting such a scheme of design would lead inevitably to failure. The necessity for running aircraft engines for long

spells at either the maximum or a very high output without impairing the efficiency of the machine by distortion or pitting of the valves, which assuredly would occur with the ordinary design employed for car service and so forth, has compelled the devotion of much thought and a wealth of experiment to the problem, as a result of which it appears to be accepted as established that the multiple valve system is a necessity.

In this connection, to achieve maximum output, I favour two exhaust valves per cylinder and two inlets.

Among the advantages of the four-valves-per-cylinder scheme are that a good shape of engine head is obtainable with it, as well as the best sparking plug position, because that is vertically in the centre of the head. The inclination of the valves necessary for putting them into place allows of ample water-jacket space being provided round each valve and at the base of the sparking plug.

Three Practicable, More than Four Undesirable.

Judged by achievement to date, any other combination of valves per cylinder will not give quite the same degree of efficiency. Take such variants as three valves per cylinder on the principle of two exhaust and one inlet valve. While giving perhaps a better-shaped, because circular, head that can be machined practically all over, this combination practically precludes any other sparking-plug position than in the side of the barrel. For obvious reasons, such an arrangement has many disadvantages. Nevertheless, the three-valves-per-cylinder scheme gives quite notably good results when exploited in certain ways and for certain special purposes. This may be judged from the fact that the diameter of the inlet valve can be made large enough to-day to give a very high horse-power per litre capacity without involving serious trouble, such as would arise from heat effects, and so forth.

The use of more than four valves per cylinder is undesirable. It seems hardly possible to place them efficiently, leaving an even jacket all round each valve, without the employment of very complicated gear. We have an example of this in the Maybach engine, which has three exhaust and two inlet valves per cylinder. In this scheme little water space is provided between the valve seats, while the sparking plug is, besides, set horizontally in the side of the cylinder barrel.

Undoubtedly in any type of engine it is a gain when the surface of cylinder head can be machined. This is not possible, however, with the four-valves-per-cylinder design. Hence in that case a compromise is achieved by making the surface as small as possible and by finishing it as much as possible by hand with files, scrapers, and so on.

Progress in Castings and Alloys.

In the manufacture of aircraft engines more and more use is being made of aluminium alloys of varied analyses, each to suit some particular condition of work. With a continuance of advance in knowledge of heat treatment and so forth, there is no gainsaying that this material will be employed for aircraft engine construction to a greater and yet more great extent.

Aluminium Alloy Pistons.

Under this head it falls to be observed that for about two years I have standardised aluminium alloy pistons with excellent results. Even when they have been made with a green sand core no real trouble can be said to have been experienced with them. A point to note, however, is that the greater clearance needed when the aluminium alloy piston is cold represents a disadvantage in comparison with cast-iron pistons which has not been overcome yet.

Special Alloys in Place of Gunmetal for Oil Pump.

Another special alloy is being used in place of gunmetal for the construction of the oil pump employed for the forced-feed lubricating system. These details are of the gear-wheel type. As regards both strength and bearing qualities the alloy employed has proved to be fully as satisfactory as the gunmetal used formerly.

Problems Presented by New Materials.

Before quitting the subject of materials in general, at this juncture it will be convenient to pass the general situation in rapid review. Manufacturers have been called on to make immense efforts in the matter of supplying a wide variety of materials for multi-cylinder aircraft engines. They have met and mastered right ably the usual sequence of difficulties that materialise whenever man attempts to break fresh ground. In particular, the high-tensile steel stamping now being supplied, for instance, for a six-throw crankshaft for a 500 h.p. aircraft

engine, is a splendid example of the steelmakers' craft to-day. There would have been no call for it had not the event of war made it necessary on a sudden for us to standardise in these islands aircraft engines of high output. Of course, the necessity for using unprecedentedly high-class materials for these constructions has presented alike steel makers and alloy producers, as well as the engine makers' machine shops, with a series of fresh problems which have had to be overcome detail by detail before it has been possible to obtain that degree of success which is necessary ere any given product can be regarded as a practical proposition.

Briefly, there has had to be an all-round improvement in method. More scientific control has had to be exercised and procedure elaborated. Obviously, there has been a call for devoting the greatest attention to detail, since it will not suffice merely to employ more expensive workmanship and higher grade materials. In regard both to design and to procedure each part must be accorded, besides, greater attention to detail than any that has sufficed for car engine design and production to date. In what direction this extra study is needed is discovered, of course, by the laborious process of experiment. After that knowledge has been attained, when it comes to standardising practice in the shops, very special attention has to be given to avoid points likely to start fatigue flaws. At this stage these are a prolific source of trouble in the production of aircraft engines. Each man has to be trained to give the correct proportion of attention to the various details of his job; therefore a more highly-skilled class of labour is needed. Your individual worker must know precisely what function his particular task and the part which he is engaged in fashioning plays in the scheme of the complete and, necessarily, at present somewhat complicated aircraft engine. Though only a matter of lightening, such details as boring parts, with which the car engine builder is not concerned, have to receive more than ordinary intelligent and conscientious attention during manufacture.

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Points about Cooling.

Considerable divergence of opinion still obtains among engine builders and radiator makers concerning water-cooling. The author is of opinion that, because increased flow of water would allow of the employment of a smaller radiator surface, that line of development is likely to be considered in the near future.

Another important matter concerns the rendering adjustable of the cooling capacity, or the surface, to suit variations of climatic conditions and of altitude. Assuredly, this is highly desirable. The conditions under which aircraft are being used to-day renders such a development well-nigh imperative. The use of radiators of relatively less size, such as is to be expected from speeding up the flow of water, should afford a notable advantage in this particular connection.

It is to be noted that air-cooling is coming into favour increasingly. It would appear that to date relatively very little has been done with multiple valves as applied to air-cooled engines. Yet in the matter of the advantages of employing multiple valves to the number of four per cylinder, it would seem that the gains of this system as applied to water-cooled engines should obtain equally in the case of the air-cooled varieties. Further, the small valve is likely to give more satisfaction in air-cooled than in water-cooled engines by reason of the time factor in the conductivity of the heat from the individual valve to the adjacent parts of the cylinder. For these reasons, among others, in the near future air-cooled engines of larger power may be expected to materialise. Certainly this type is very promising.

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Anticipated Great Alterations in Design.

When this war began there was relatively little fighting in the air, and the average flying was done at anything from 4,000 to 6,000 ft. To-day our airmen rarely go over the lines at less than 16,000 ft., and fighting has taken place certainly at altitudes of 21,000 and 22,000 ft. Accordingly, it will be realised that at the outset of the campaign the problem of altitude was not thrust to such an extent on the attention of the designer and the manufacturer because such modest heights were deemed sufficient for aerial reconnaissance and other work, whereas in the interval it has become imperative to navigate the air at such vastly increased heights that the difference in atmospheric pressure can be ignored no longer for the sufficient reason that the altitudes in question could neither be attained nor maintained if the problems presented had been not solved, at least in part, already. They concern both carburation and engine compression as well as the matter of cooling.

The alleged method of increased compression exploited for Zeppelin service as a means of

tackling this problem is peculiarly suitable for airships owing to it not being necessary for those craft to climb by mere engine power, also to the fact that a major part of their work is done at high altitudes. It is possible that the engines in which small change in atmospheric pressure is allowed for are used entirely for work at high altitudes, and have a much higher compression than those which are employed for manœuvring Zeppelins near the ground.

Of course this question of compression is interconnected with the problem of carburation; hence we must also regard altitude as a governing factor in the design of the latter-day aircraft engine. In the last few years considerable advance has been made in the degree of compression standardised successfully. Thus engines with a compression ratio as high as 6 to 1 are running satisfactorily at sea-level to-day. That, however, has been rendered possible only by evolving such a combination of features as valves of suitable design, diameters, and openings, and by going very scientifically into the matter of cylinder-head design.

Method of Rating.

From the inception of the movement several methods have been proposed for rating petrol engines. At the stage at which we have now arrived in constructing power plant for aircraft service, some figure seems to be needed which will give a notion of the efficiency, or horse-power output, of an engine in relation to its size. To-day the mean pressure is used often for this purpose; but, in my view, that is neither convenient nor can it be arrived at easily.

For this reason I wish to propose that the horse-power per unit capacity obtained from any given engine be taken as the standard for preparing the different "duties" of engines. Of course, the figure obtained is proportionate to the mean effective pressure, but doubtless it will be agreed that it is more convenient.

The capacity taken would be the capacity per cylinder multiplied by the number of cylinders and by the number of complete cycles per minute; but to serve the aim in view the horse-power per litre engine capacity per 1,000 cycles, otherwise per 2,000 crankshaft revolutions a minute, is proposed.

THE IRONSTONE OF THE LIAS.

The calcareous ironstone of the Middle Lias attains its best development in the neighbourhood of Banbury in North Oxfordshire. The outcrop is along the ridge of high land bordering the northern part of the county, and the maximum thickness is about 30 ft. It is on the same horizon as the Lias ironstone of Cleveland, a district famed for the excellence of its iron. The field covers the greater part of North Oxfordshire, extending as far southwards as Great Tew and Fawler near Woodstock.

The three seams which make up the rock mass vary considerably in their composition; the upper, the "road stone" seam, is a hydrated ferric oxide, yielding 33 per cent. of iron in good localities. The underlying "rag" seam has six or seven beds of blue-green oolitic stone with red stone partings, bearing a lower percentage. The bottom stone seam yields 3 ft. of stone of a lighter texture, an oolitic green carbonate with joints, partings, and coatings of red stone. The higher, the road stone beds, make up about 10 ft., the middle beds about 6 ft., and the "bottom stone" about 4 ft. of the ordinary quarries; but with the bottom stone should be placed about 3 ft. of red "oven" stone separating the middle seam from the lower beds.

It appears, from investigation made by the writer, that the stone was originally a calcareous *remanie* of a deep sea-floor, a tangle of crinoidal life accumulated in successive stages of growth, whilst occasional periods of parasitic growth of mollusca patched and banded the tangle into the Lias limestone, which long periods of time, and decay of overlying strata, charged with iron mineral. Considerable differences in the structure of the stone are met with in its range of twenty miles north to south, and twelve miles east to west.

At Edge Hill and Hook Norton there are beds 6 in. or more in thickness of ferro-crinoid stems. At Astrop and Byfield the upper seam is largely composed of small crinoid segments, which are spread throughout a series of thin beds. Bands of shells of brachiopoda are persistent in the middle and upper courses, and clustered masses of the Rhynchonellæ and Terebratulæ are scattered throughout the rock mass.

The Edge Hill quarries have been worked for an excellent building and paving stone from long distant time. Its mineral exploitation is now being taken up with that of the southern area. Extensive workings at Adderbury, Astrop, Hook Norton and Byfield, with steam shovels and numerous calcining furnaces, have been carried on for many years.

The gradual fall of the surface and rock from the Edge Hill area towards Banbury (*i.e.* from about 700 ft. altitude to 350 ft.) presents conditions favourable to mining enterprise certainly equal to that of the sharp fall of the surface from the escarpment ridge to the Kineton plain—a plain traversed from east to west by the East and West Junction railway. The nearness of the Warwickshire coalfield

should also aid in the development of the area which the several new companies are beginning to exploit. One of these is the Oxfordshire Ironstone Co.

The whole field almost is drained by the effluents of the River Cherwell. The grounds of the Nen in Northamptonshire are covered by Upper Lias and Inferior Oolite, bringing in, as they fall eastward, the Northamptonshire iron ore to which the Lias is often now conveyed from the mines near the Oxfordshire border. The calcareous type, and perhaps more open structure of Lias stone, is said to help the smelting of the Inferior Oolite ore. Why the Lias stone should dwindle, disappear, or lose its ferruginous condition with the Nen drainage is not yet open to our knowledge. In an "Account of the Geology of the Brackley Town Well," printed in the *Buckingham Advertiser* in 1912, the writer pointed out the complete removal of the Lias ironstone series as well as the thick limestones above the Inferior Oolite. The Middle Lias is not the only calcareous bed which vanishes with the high lands of the Nen—one of the greatest of the sub-Bathonian rocks (the equivalent of the Lincolnshire limestone) is wholly removed. It also makes an excellent ironstone to the north-east.

Opencast mining is now conducted by the Adderbury Ironstone Co., the Astrop Ironstone Co., the Bloxham Ironstone Co.: and the Brymbo Iron and Steel Co., the Baker Co., and Earl Dudley's at Hook Norton, the former with three calcining tuers. Sir A. Hickman's workings have nine tuers. On the contiguous Northamptonshire border are workings at Byfield by the Northamptonshire Ironstone Co., and another company at Charwelton.

EDWIN A. WALFORD, F.G.S.

SPANISH FORESTS AND PAPER MANUFACTURE.*

The Spanish market uses annually 28,000 tons of paper, of which newspapers account for one-half. Spain produces 15,000 tons of mechanical pulp per annum, from which an approximately equal weight of paper is manufactured. Consequently she is obliged to import 3,000 to 4,000 tons of mechanical pulp and 10,000 tons of chemical pulp.

Trackless Forests.—It is asserted that there is sufficient wood in Spain to cover the amount of the imports, and that it is the lack of roads which hinders the working of the woods under economic conditions. In Spain the raw material for paper-making is not very costly, but no one cares about it, and the forests remain practically unused. As an instance may be cited the magnificent fir woods of the Aran Valley, consisting of *Abies pectinata*, the species best adapted to paper-making. A beginning was made in the management of 37,500 acres, and the yield from these forests reached nearly 16,000 cubic yards. Unfortunately the work was stopped on account of administrative difficulties connected with boundaries and other questions of secondary importance.

Workable Woods.—In the Pyrenees of Aragon and Catalonia, chiefly in the provinces of Huesca and Lerida, there are 122,500 acres of fir woods, capable of providing 39,000 cubic yards of wood per annum. As the wood has a high moisture content this quantity would make about 15,000 tons of mechanical pulp, or 10,000 of chemical pulp, which is nearly enough to tide over the crisis that the war has caused in the paper trade. It does not seem possible to work these 122,500 acres in an intensive manner all at once, and it is suggested that the working of the Aran Valley, mentioned above, should be continued; the 39,000 cubic yards of wood obtained would be equivalent to 6,000 tons of mechanical pulp, or 4,000 tons of chemical pulp.

The remainder could be provided by the pine forests (*Pinus sylvestris*) of Soria, Burgos, Sierra Carpetana, and Cuenca. The Spanish pine wood contains more resin than that from the Baltic and Sweden, and consequently is less suitable for paper manufacture. Nevertheless, this species occurs at various altitudes, and it is probable that *Pinus sylvestris* from the dense woods of the higher parts of the country closely resembles that from Northern Europe.

The conclusion is drawn that the problem of providing raw material for paper-making could be solved if the Forest Administration were to take the matter up seriously.

Transport.—This is a more difficult problem to solve than the preceding one. In practice the freight from Sweden to Spain, to Pasajes (Guipuzcoa Province), is lower than the cost of transport from Sierra Guadarama (Province of Madrid and Ségovia) to Guipzcoa or Biscay, where important Spanish paper factories are situated. The Government may prevail upon the railway companies to concede a lower tariff, but it cannot improvise means of road transport.

The Spanish paper industry has a producing capacity great enough to meet the needs of the country; the Spanish Paper-making Company is responsible for 68 per cent. of the total output. Apparently means are available to produce the whole of the mechanical pulp necessary, but not the chemical pulp, because the manufacturers are not provided with the needful plant. The paper factory at Villalba (Navarra) is an exception to this, as it produces a small quantity of semi-chemical pulp.

Replanting with poplars, especially Canada poplar, is suggested as a means of providing the most rapid solution of the problem, while at the same time it would give a return of 12 to 14 per cent. on the capital outlay.

* Reprinted from the *International Review of the Science and Practice of Agriculture.*

UTILISATION OF SAWDUST FOR COOKING.

A simple and ingenious contrivance for cooking, utilising sawdust for fuel, has lately been introduced at Nice with good results. The little stove used consists of a cylindrical box made of sheet iron, about 7¾ in. in diameter, and 8 in. deep, without lid. This is filled with sawdust to within about 1 in. from the top, leaving the rim, which is pierced with eight holes ⅜ in. in diameter, uncovered. Three small pieces of sheet iron, bent at right angles, riveted inside, below the top, serve as brackets to support the saucepan or other cooking vessel at the right height above the charge of sawdust. It is also provided with two light handles for convenience in moving. Before filling the charge of fuel, a piece of wood 10½ in. long, tapering from 1¾ in. diameter at one end to 1¼ in. at the other, is placed, small end downward, in a vertical position on the bottom of the box. Another piece of wood, 1¼ in. diameter and 6 in. in length, is inserted through a hole in the side, at the level of the bottom. One end of this piece is slightly hollowed so as to fit the lower end of the vertical one. These two pieces of wood form a kind of core or mould, round which the sawdust is firmly packed with a wooden rammer. When filled, the wooden moulds are carefully withdrawn, leaving a vertical and a horizontal hole.

For lighting, a few drops of petroleum should be poured down the vertical passage, and a lighted taper is then inserted through the horizontal one. After a few minutes, when the sawdust is well alight, the cooking vessel may be placed on the stove.

A charge of fuel, which will last from three to six hours, will be sufficient to cook the dinner of a small family, as well as heating a kettle of water to wash up afterwards. The stove will be also found very useful for heating a flat-iron and other domestic purposes.

SWISS MUSICAL-INSTRUMENT INDUSTRY.

According to a report by the United States Vice-Consul at St. Gall, organ-building in Switzerland has been brought to a high degree of perfection, and Swiss organ builders have become world-renowned. Since 1864 the two oldest Swiss firms engaged in making these instruments have finished almost 1,000 organs with single, hydraulic, and bellows working.

The Swiss manufacture of pianos may be traced as far back as the first half of the nineteenth century. In 1842 and 1847 the first Swiss piano factories were established, followed by others in the years between 1870 and 1880. A certain decentralisation in this line of manufacture made itself felt in a most advantageous manner, which greatly and beneficially influenced the quality of the instruments, for the various mechanical parts and keyboards are now made by special manufacturers by means of precision machines, whereas the piano factories devote their experience and labour to a harmonious construction. They are provided with modern and effective drying chambers for the necessary treatment of the wood, so that it remains unchanged by the influences of the weather or the tropics—a fact of special importance for the export trade. More than 80,000 instruments have left Swiss factories, and now the monthly production in eight factories is as many as two hundred instruments of high quality.

Of more recent date is the manufacture of pianoforte players, which also has met with success. The two systems, Phonola and Dea, have a good reputation. Concertinas are produced chiefly in the district of Langnau. They are very carefully made in small quantities, and are said to be superior to others on account of the clearness and softness of the tone. The manufacture of wind instruments is carried on particularly in the Canton of Berne, where it became established about the middle of the last century. Originally it was the turners who took up the manufacture of wooden wind instruments. Gradually they began to occupy themselves by making valveless brass instruments, key bugles, and, finally, valve instruments. Switzerland now possesses a well-known permanent industry of wind instruments which has its principal seats in the Cantons of Berne, Aargau, and Basle.

The manufacturers of string instruments—the oldest firm in this line started at the beginning of the last century—have refrained from manufacturing instruments on a large scale, and have paid great attention to quality.

The construction of orchestrions, phonographs, and gramophones should be mentioned. These are made principally at St. Croix, a town which works especially for the export trade.

ENGINEERING NOTES.

High Tensile v. *Mild Steel for Reinforced Concrete.*—Mr. A. W. C. Shelf, in his paper on this subject recently read before the Society of Engineers, said since reinforced concrete was introduced it had been customary to employ plain round mild steel bars for the above purpose. He endeavoured to prove that plain mild steel bars are not the best to employ for this purpose, but that greater efficiency and economy are obtained by physically developing mild steel bars for the purpose of taking out the first yield in the steel, which is useless and has a detrimental effect in concrete. When this first yield is taken out a higher yield point is obtained without any injury to the steel, so that it is safer to employ a stress of 20,000 lb. per square inch—which results in a saving of 20 per cent. in the weight of steel required—than it was to

employ a stress of 16,000 lb. per square inch before the steel was physically developed, and for this reason the author of the paper thinks that the existing regulations of the London County Council relating to the stress on steel should be altered to avoid the cramping of industrial progress.

Fixation of Nitrogen.—The *Engineer* observes that a development of considerable significance is about to be made in Manchester in connection with the manufacture of nitric acid. We understand that a plant for the separation of nitrogen from the atmosphere by the Kilburn Scott three-phase process is about to be erected in the neighbourhood of one of the largest power-stations. Electrical energy for the process will be obtained from the Manchester Corporation, and the installation plant will require about 1,000 h.p. If successful, however, the apparatus will be largely increased. As there is an immense demand for nitric acid at the present time, for the manufacture both of explosives and of fertilisers and other products, the experiments will be regarded with special interest. Mr. Kilburn Scott has taken out several patents connected with the fixation of nitrogen from the air, and we believe a small experimental plant has already been at work in the district. The furnace utilises the three-phase alternating current. In one form three hornshaped electrodes are arranged at 120° apart round a central metal pipe. This pipe is earthed, and forms the neutral point of a "star connected" three-phase system, each of the electrodes being connected to one of the phases. The bottom of each horn electrode approaches close to, but does not touch, the central pipe, and provision is made for starting arcs between the electrodes and the pipe. The inventor claims that the arc flames travel up the diverging electrodes, and, following each other at every half period of the alternating-current supply, give practically three continuous arc flames in the spaces between the electrodes and the central pipe. The arcs are driven upwards by three blasts of air, which issue from a nozzle in the central pipe. The inner tube of the pipe projects upwards to a point about level with the top of the electrodes, and at this point there are three further nozzles, from which further blasts of air emerge. These blasts provide the cold zone which is necessary for the fixation of the nitric acid gas. The air which drives the arcs upward is preferably at a high temperature, but the air which emerges from the top of the pipe must be as cool as possible. The upper part of the central pipe is liable to be burned away, and to prevent this it is surrounded by a tube which is easily renewable. It is claimed on behalf of this process that it enables nitric acid to be produced with considerable profit, the output per kilowatt year being about 1½ tons, which, at the current prices, should leave a handsome margin for the manufacturers. It remains to be seen how far the project will fulfil the anticipations of the promoters.

A Rateau Turbo Set.—A 6,000 kilowatt, 1,500 revolutions-per-minute turbo set, installed at the Port Dundas station of the Glasgow Corporation, illustrates the reliability of a modern steam-turbine unit and the importance of coal consumption. The turbine is of the Rateau impulse type, designed for 190 lb. square inch pressure, and 166° F. superheat, containing a velocity wheel, followed by ten Rateau impulse stages, the maximum tip speed being 553 ft. per second. It is coupled to a three-phase 50 period 6,600 volt generator. The set was started up in February 1914, and had generated 100,000,000 units by August 1916, so that with a coal consumption of 1·75 lb. per kilowatt hour, the coal used by the set would amount to 78,250 tons in two and a half years, or at the rate of 31,500 tons per annum, which represents a coal bill of £23,500 per annum, with coal at 15*s.* per ton, so that each 1 lb. improvement in steam consumption saves about £1,710 per annum in cost of fuel alone. The above particulars are from the *Engineer.*

Power from Strangford Lough.—In a paper relating to Irish water-power, read recently before the Association of Municipal Authorities in Ireland, Mr. McAndrew estimated that 50,000 h.p. could be recovered for eight months in the year, and 20,000 to 40,000 h.p. during the dry season. Amongst the most interesting of Irish power schemes, however, was the utilisation of the tide into and out of Strangford Lough, as proposed by Mr. A. W. Brown. This sheet of water has an area at low tide of about twenty square miles, while the entrance to the sea is only a quarter of a mile across in places, and could easily be dammed. It is obvious that an enormous amount of power is running to waste in this entrance, through which a huge volume of water passes four times in every twenty-four hours. Possibly as much as 100,000 h.p. might be obtained in this for twelve out of the twenty-four hours. The electricity generated thereby could easily be transferred to Belfast.

GENERAL NOTES.

Seeds of the Japanese Medlar for feeding Poultry.—It is not generally known that the seeds of the Japanese medlar (*Eriobotrya japonica*), a tree which is grown for its fruit on the French Riviera, can be used for feeding poultry, rabbits, and other domestic animals. They can also be used for distilling a spirit resembling *Kirschwasser*. Food for poultry can be prepared by simply boiling the fresh or dried seeds in water

from thirty to forty-five minutes, and then crushing or using them whole, as may be desired. Instead of being boiled, they may be roasted like coffee. Another plan, which has the advantage of not requiring heat, is to moisten the seeds with sufficient water after being first crushed, and allow them to remain in this state for twelve hours. The mass is then spread out in a thin layer to dry in the sun, in order to remove any traces of the flavour of bitter almonds. This food can be used dry or wet as preferred.

Proposed Aerial Postal Service between France and Corsica.—It is proposed shortly to establish a regular postal service by seaplane between France and the Island of Corsica. The following are the distances of the routes proposed :—

Marseilles and Ajaccio	320 km.	(200 English miles)
Toulon and Ajaccio .	290 „	(180 „ „)
Nice and Calvi . .	180 „	(112 „ „)

From this it will be seen that there is no lack of choice for a suitable starting-place on the French coast, after a careful study of the winds and other atmospheric conditions. There are, no doubt, a large number of suitable aircraft which, if no longer serviceable on account of speed for military purposes, might be utilised by the French and English Post Office authorities for similar services in both countries—for instance, across the Channel between Dover and Calais, England to Ireland, as well as to the Isle of Man, etc.

New Zealand Grape Industry.—It appears from a report by the United States Consul-General at Auckland, that grapes are not grown very successfully in the open in New Zealand, since the climate is too moist and cool to allow the fruit fully to mature. There are about 390 acres of vineyards under cultivation, located in the most favourable spots of the Dominion, where limited quantities of middle-quality grapes have been grown ; but the grape is not considered a very profitable crop. During the year 1915 there were 89,800 gallons of wine manufactured in New Zealand. The vineyard grapes retail at from 4*d.* to 6*d.* per lb. Some most excellent table grapes are grown in this Dominion, but in vine houses instead of in the open air. There are about 800 of these vine houses in New Zealand, and all seem to be doing a thriving business, especially in the South Island, where practically no grapes are grown in the open. Grapes grown under glass retail in New Zealand for 1*s.* 6*d.* to 2*s.* per lb., and always find a ready market.

Edible Beans in North Manchuria.—No white beans, or beans of commerce, are grown in North Manchuria, soya beans for oil being almost the exclusive bean crop. One variety of edible bean, however, says the United States Consul at Harbin, is grown for local consumption. This is the macaroni bean, called the "little bean" by the Chinese. It is of a red and yellow colour, and is consumed solely by the Chinese. It has never been exported. It is thought that from 75,000 to 100,000 pouds (1,000 pouds = about 16 tons) might be obtained in the market. The beans are cleaned by hand and shipped in gunny bags holding 5 pouds (180 lb.) each. The freight from Harbin to Vladivostok is 19 copecks, or about 3*d.* per poud.

Electric Announcer at Dutch Auctions.—The Office of the United States Commercial Attaché at The Hague reports that at the regular trade auctions held in the Netherlands, instead of having an auctioneer call for bids there is a large dial provided with an index hand. The face of the dial is marked with prices increasing in clockwise fashion. The hand is set at a price above that which the goods offered will probably bring, then is slowly moved to lower and lower figures until some trader indicates his willingness to buy. Electric push buttons are connected with the dial, which the traders press when a price satisfactory to them is shown by the dial. As the trader presses his button his number appears on the face of the dial, and the lot of goods is sold to him at the price indicated by the index hand. There is no noise or confusion, and the auctions are finished in a remarkably short space of time.

Agricultural Machinery in Palestine.—A memorandum prepared by the Arab Bureau and forwarded by H.M. High Commissioner in Egypt contains some interesting information on the subject of agriculture and supplies in Palestine. A good deal of dry scientific farming is carried on in the neighbourhood of Jerusalem, the ground being kept loose by continual tillage. The Arabs do not use harrows, but the Jewish colonists have introduced the harrow and American pulverisers with beneficial results. The ploughs chiefly in use in Palestine are the primitive Arab plough and the German ploughs used throughout the Jewish and German colonies. British ploughs are said to be too heavy and of not quite suitable shape. In the orangeries and other plantations American ploughs are used exclusively, and American zig-zag harrows are also employed. The use of the American disc harrow is common, and American harvesters are in fairly general use even among the Arabs, whilst the Jews employ American binders. In the Jaffa orange district the irrigation of the new groves is effected by means of pumps operated by oil engines. Most of these are of British make (3 to 8 h.p.), and it is estimated that there are about three hundred of them. There is a great shortage of spare parts. A grove of twenty acres is the minimum economic size for a separate pumping plant.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

CIVIC ARCHITECTURE AND TOWN-PLANNING.*

By PROFESSOR BERESFORD PITE, F.R.I.B.A.

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Lecture I.—Delivered January 29th, 1917.

The art of planning is not confined to utilitarian ends, but also includes sentimental aims. Convenience and an idea will, taken together, arrange the temple or palace walls, columns and arches, giving occasion to the forms that, in grouping, in light, shade and colour, appeal to the eye, but retaining for the plan the secret of their effect. Civic architecture or town-planning, similarly, combines usefulness with the sentiment of the beauty of orderly service. The scale is greater and the factors more miscellaneous than in any single work of architecture; but the motives of plan-design are the same, extended from the item to the total, from the single building on a site to the city, which includes both building and site in one term. The larger concept of a town is an aggregate of greater interest, though less tangible, than that of any single building, for its multifarious items require co-ordination without loss of character or economic convenience: the humblest dwelling has its demand no less than the palace, and the civic architect watches for the idea that shall give individuality to the mass. The beautiful city has more character than the adventitious charm of a romantic site or the specialised interest of a monumental building; like all other rational work of man, it will have advanced to definite success along that path of usefully humble work beautifully done, which is, in fact, the way to art.

There is an architecture in planning—apart from the accepted ideas of architectural style, which consist in the main of systems of construction and decoration—that is well-nigh cosmopolitan in its sense or standards, of fitness and beauty. This universality of impression may be discerned as far afield as Mitla in Mexico in the West, or in the Dravidian temples of Southern India; it is at Thebes and at Babylon; it directed the Alexandrian ideals, and descends from Imperial Rome with lessening force to the modern world. It is the art of the city map, seldom content with the chess-board simplicity that achieves plan without design, though usually rectilineal and formal, and its principles have established themselves into a convention that appears to be as common as civilisation.

Though the art of noble civic planning cannot be exhaustively analysed like a science, its qualities are to be distinguished for study and practice: they include geometrical form, rhythmical arrangements, the employment of a central and other axial lines, due emphasis of parts, and the recognition of the value of those accidents that constitute picturesqueness. The marshalling of the blocks of a city plan into an artistic system, the lines of approach to its principal buildings and public squares, and the constant pursuit of dignity and beauty, are illustrations of what is worth doing well in city-planning, making the larger development of material civilisation at once convenient and artistic: this is for the public good, and it is for us to do it to-day.

The material for study afforded by history is limited, the remains of ancient cities are but partially explored, and the social life of past epochs is not yet fully co-related with their monuments. Athens, by a few wondrous buildings, reveals much of the craft of her architects, though we know little of the domestic

* The course consisted of four lectures, delivered on January 29th, February 5th, 12th, and 19th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into six parts.

surroundings of the builders. Hebrew sacred literature, on the other hand, has a supreme doctrine of social life, ultimately embodied in the ideal city; but the race has not given us a single concrete type of its own architecture or art. The historic study of practical town-planning is thus in many directions limited, if not impossible; but if the survey be enlarged to review the growth of the qualities of noble planning, definite principles may be discerned capable of application to-day in this, perhaps the widest, sphere of modern architectural practice.

Beneficent control that, by enlightened instinct, orders the various elements of a great city is an ideal which enhances civil life. Zeal to promote an architectural design may, in a free community to-day, prevail to achieve results that despotism attained in the past, if the reasonable appeal of the essential economy of order in city building is considered. If this is at all understood, it may be anticipated that the beneficent tyranny of municipal action may recover for the streets of our towns that sense of the necessity of order and plan which in other departments of public government, such as finance and sanitation, refuses to endure lop-sided and disorderly arrangement. We shall look in vain for any completely realised ideal to history: magnificence in planning involved a huge employment of labour and extravagance in material, necessary to the despotic pride of the designers. Such architectural glory is seldom the ideal of free communities. National liberty may be descried in Greek lands prior to the Macedonian era, in republican Rome, in the free cities of the Middle Ages, and in constitutional England by the very absence of civic grandeur. The squalor of Sparta and the tangle of Rome, when the city was herself, are, however, almost forgotten in the estimate of their historic influence; but the slaveries and inane toil of Egypt and Assyria will continue in evidence so long as the grandeur of their monuments survives. The contrast may seem inevitable, but the conditions are not. A satisfactory conclusion may await the consideration of both the concrete achievements of the past and the municipal ideals of the present. The architecture of town-planning of necessity must assimilate both.

The study of the plans of the earliest cities and buildings known to history is refreshing to the civic architect, harassed in his outlook by the narrower ideals of to-day. Though the immediate purpose in view, and the means by which it was sought to be attained, belong to ages long past, these immense plans are not unfruitful of suggestion. We do not lack either the opportunity or the means to achieve great results, for the co-ordinated interests, population and wealth of a single modern city are factors as pregnant as those employed by any of the great city builders of antiquity. The detailed factors of civic life have multiplied with the fulness of its interests, and the task that an enlightened public should demand is their organisation through town-planning towards an architectural ideal.

Egypt.

The architecture of the ancient East is in a descending scale of vastness: the wide plains and great river of Egypt cultivated imaginative conception; the scale originated in the Pyramids is still the most vast, it descends to colossal buildings of the Theban kingdom, and passes onward in slow but real diminution to the cities of the Mesopotamian plain.

The principles of setting all buildings upon a regular and geometrical scheme duly adapted to the site, qualities of plan that are essential to-day, are manifest in the arrangement of the earliest structures of civilisation—about 3000 B.C.—at Memphis on the Nile in the vast and impressive Necropolis. The great pyramids, groups of smaller tombs, and the temples were set out upon an elevated rectangular platform, enclosed and prepared at some distance from the river in order to be secure from floods, and large and substantial causeways were formed that would be compressed and solidified by the transport of material. The great buildings of this city, the pyramids, are deposited parallel to the enclosure and to one another; the smaller are grouped around the larger and are surrounded by graves. Each pyramid has a central avenue of approach from a small temple placed upon the axis. The great pyramid in the centre of each group is placed *en échelon* with the next in order to obtain unobstructedly the beams of the rising or setting sun.

A transparent geometry orders this ancient and still predominant aggregation of buildings: it is primarily regular and ordered; the buildings are architecturally featureless, even the Temple of the Sphinx is wholly rectilinear, and has neither details nor forms that betray interest apart from the plan. But lest we should conclude that the builders had been unconscious of the high

service and meaning of plastic art, the sculpture of the rising sun or sphinx concentrates and embodies its marvellous ideal at the entrance to the sacred enclosure, and adds the variety of sculptured form to the stern lines of pyramids.

The millennium that ensued upon the age of the pyramid builders witnessed the development of Egyptian power higher up the Nile. Astride the river at Thebes, the key of Middle Egypt, was planned and built the greatest city of the ancient world, the metropolis of an empire extending from the deserts of Ethiopia to the already considerable cities of Damascus and Nineveh. The great Theban period of the eighteenth and nineteenth dynasties is five centuries previous to the exodus of 1312 B.C. The architectural scene has now entirely changed from that of Memphis: a constructional and decorative system had been evolved that was virile enough to maintain its character and style for another 2,000 years. This art, already full grown at the early dawn of European civilisation, planted on the Nile wonders that became the ideals of the later Assyrian, Babylonian and Persian palace builders, in a city that was the fount of all Eastern dreams of architectural magnificence, as well as of those Roman imperial glories of planning that to this day underlie all civic architectural design.

Thebes—still, in Fergusson's words, "the most colossal assemblage of ruins in the world"—consisted, on the western or left bank, of the great temples of the Ramesseum, of Medinet Abou with others, and the Necropolis, extending back into the hills and including the great royal tomb of Hatasu, or Dehr-el-Bahari. On the eastern or right bank lay the greater temples of Luxor and Karnak, connected by the famous processional road. The situation of the town on both banks near the river necessitated the formation of an elevated platform, laboriously constructed of cross walls and filling in, surrounded by immense fortifications of crude brick that have dissolved away. The city was laid out and practically accomplished within a century, though succeeding dynasties from generation to generation, down to the time of the Romans, continued to add to the temples.

The arrangement of the city plan cannot with any certainty be recovered. The vast temple enclosure at Karnak was reached by the grand avenue paved with stone of a width of 76 ft.; on to this streets abutted so narrow that chariots could scarcely pass between the houses. This great royal approach, or processional road, was bordered, not with buildings, but with sculptures of sphinxes, from which its special magnificence was derived: similar sacred ways recur in many other cities of the East. The national activity and wealth were directed to the building of magnificent architectural monuments, and there is little evidence of the generalised planning found at the Necropolis of Memphis. Dignified arrangement belonged either to the city of the dead or to the temples of the unseen, and eschewed the dwellings of the living. The organisation of the town was not, however, entirely neglected, and its social conditions appear in the small size of the houses and streets. The construction is economical, and the narrow geometrical laying out involved the loss of freedom and spaciousness. Blocks of houses intersected by narrow lanes formed the city and resemble the Anglo-Indian compound. The houses, as represented on the walls of the temples and tombs, had only two floors and flat roofs, and, as the house was without a proper front, the street had no architectural existence. Gardens within the compounds marked the houses of the wealthy. The enclosing fortified wall gave external form and character to the city, but its protection was also the cause of unhealthy internal congestion. Professor Petrie has unearthed at Kahun, in Lower Egypt, a city of dwellings for workers of the earlier epoch, consisting of masses of small houses uniform in size and arranged in regular narrow streets.

In the detached and scattered ruins of the Theban temples a magnificence of scheme survives which belongs essentially to the design of the plan. Here the singleness of idea of the pyramid area with its simplicity of means is replaced by a number of elements: the unsophisticated vastness of a central mass is absent, but the nobility of the structures is obtained by a combination of factors that mainly arise from the plan. The arrangement of the internal masses of the buildings was conditioned by the columnal and horizontal system of construction: this involved a limitation of imaginative effects such as are obtained in arched or domed structures, and reacted on the development of the plan in expressing an architectural idea. The wealth and glory of the builders found expression in the constituents of the elevations as well as in the sculpture and internal wall paintings; but the whole is pre-eminently an architectural expression of plan arrangement.

The simple but grand enclosing wall of the temple, unbroken in its mass, compressed into unity and simplified the elements and parts of

varying scale which the interior contained. The great pylons flanking the entrance are reminiscent of the pyramid idea. The entrance and the enclosure are the whole; no group or mass rose above its outlines. The pyloned gate was the centre of the external effect—an obvious feature of civic architectural impression; in front of the pylons stood obelisks and flag-masts, and a stately glory was imparted to the long approach from the river, within the city, which linked the temples of Luxor and Karnak, by the avenue of statues, not buildings, on either side of the raised causeway.

Within the temple enclosure is a succession of square courts upon a continuous axis, each entered by a pair of pylons that gained for the city the epithet from the Greeks of Hecatompylos. The sense of magnificence descends into mystery through a perspective of repeating features. Courts decorated with colonnades and pools lead to pillared halls and further courts culminating in the solemn distance of the sanctuary. Geometrical repetition and symmetry of multiplication have replaced the original impressiveness of addition to the original unit of the pyramid. Thebes was thus developing an art of planning and teaching a lesson that was never forgotten throughout the subsequent vagaries of architectural evolution.

The necropolis on the western bank illustrates in a different manner from the temples the same idea of effective planning. The royal tomb at Hatasu, or Dehr-el-Bahari, consists of three enclosed courts within the pylons, rising by terraces to the sepulchral chambers excavated in the rock behind. The great ramps and steps which ascend to the doorway would seem to be the original type of a scenic splendour of plan that infected the imagination of the Assyrians and other Easterns. The open courts and ascending motive provide a conception of spacious treatment that is completely distinct from the overshadowing mystery of the temple interior. The progressive adoption of the architectural scheme of the plan and of the ornaments that belonged first to the temple and the necropolis, and their distribution in the plan of the city, will mark out a line of historical connection in civic design. The pyloned gateway, obelisks and flag-masts, the stately causeway and its sculpture adornments, as well as the colonnades, terraces, pools and ramps of the courts of the temple and tomb, eventually become the artistic properties of the architect of a town plan; but these are only accessories, the originating geometry of symmetrical planning, evident in the earliest remains of the ancient world, became a principle, which, as a practicable ideal, fixed itself on the world; it is an idea absolute and dominating that necessitates a tyranny, both for its initiation and maintenance, whether in ancient Egypt or in modern America.

Assyria.

Mesopotamia possesses, upon the banks of the Euphrates and Tigris, the earliest group of cities of historic foundation. The record of the Book of Genesis (chap. x.) is that "Asshur went forth out of that land"—that is, from the top of the Persian Gulf, the base of the present British military operations—"and builded Nineveh, and Rehoboth"—the latter word means open spaces, and has been translated as city boulevards—"and Calah and Resen between Nineveh and Calah: the same is a great city." The group of townships is probably indicated that in a succeeding age became palatial and is known to us in the ruins of Nimroud, Koyundjik and Khorsabad. At Babylon there are interesting traces in the rectangular network of the street plan of the earliest city of Khammurabi, the contemporary of Abraham, that reflect his celebrated code; it is thus different from the crooked Sumerian towns. Professor Leonard King remarks that, "under her earliest dynasty Babylon worked out in detail a social organisation that suited her commercial and agricultural activities, and that survived and imposed itself later." In his opinion, we are here in the presence of a deliberate attempt at town-planning of the era of the first dynasty. It was more than a millennium later that the prophet Jonah reluctantly visited Nineveh and "began to enter a day's journey" into this "exceeding great city of three days' journey . . . wherein were more than six-score thousand persons that could not discern between their right hand and their left and also much cattle."

The remains of Assyrian civilisation offer many striking contrasts to that of its constant rival in the Nile valley. Its buildings were of brick, enriched in later epochs with stone, and were contemporary with the granite architecture of Egypt. Egypt is expressed by supreme tombs and temples, Assyria and Babylon by marvellous palaces and city walls. The former, besides its sculpture, excelled in a wealth of decorative and descriptive painting; the latter also has wonderful sculpture and libraries of dynastic literature; but the art of great planning is common to both civilisations, and in each the arrangement of the masses of building on the

ground plan surpasses the architectural development of the vertical design or elevation.

The development of architecture would seem to have two streams—that of a planned magnificence, to a great extent independent of the finer arts, as in Egypt and Babylonia and afterwards at Rome, and that of the refinement and evolution of constructional forms, of detail and of decoration in buildings of a fixed or traditional plan, as in the temples of the Greeks or the cathedrals of the Middle Ages. The harmonious combination of these ideals awaited the Renaissance and modern world, and is illustrated at St. Peter's with its atrium, when grandeur of plan had become an artistic consideration; and the same union of ideas underlies the magnificent design by the artist-antiquary, Inigo Jones, for the palace at Whitehall. In the design of most public buildings to-day the plan and elevation, as separate ideas, have effected a practical working agreement which is recognised as necessary to civic architecture; but the notion that a dignified organisation of the masses of a plan is an artistic end in itself is not yet recovered or recognised. This is a civic art fundamental to town-planning; to the city builders of the ancient empires an instinctive sense of spaciousness and for great forms in plan came as a primal element necessary to their civilisation, and therefore their work and its motives are not without value to the student.

The great Assyrian and Babylonian towns are primarily cities of the palace, with extensive but wholly subordinate districts of streets containing their notoriously huge populations. Nearly always "the city lieth foursquare," and usually is diagonal to the cardinal points, the angles of the wall pointing north and south, east and west. As this arrangement was repeated in the blocks of the parallel streets, an advantageous distribution of shadow and sunshine was procured, no building being entirely sunless on any of its walls.

The banks of the river, selected for the site, were walled for fortifications and quays; sometimes the city was placed astride the stream, which—like the Thames in London—was the street in the midst of it, and then would be doubly embanked and fortified. The site was prepared thoroughly by the construction of a level platform, sometimes raised to more than 40 ft., and upon this a further platform would be placed for the floor of the palace. The extent of this preliminary work will excite our admiration, and the sanitary economy of its costliness our envy. Inundation was avoided by this essential step; the sanitary problems of the civic engineer were simplified, and its architectural value marked the forethought of the designer of a great city. Upon a smaller scale the Temple enclosure at Jerusalem was raised and levelled by Herod the Great, exalting a valley and levelling a hill-top to the extent of 40 acres. Trajan attempted a more difficult task in his forum amidst the Septimontium at Rome, and a recent distinguished illustration of its value is the site prepared at vast expense for the Palais de Justice at Brussels. But while these platforms form part of their cities the Assyrian prototype extended to its whole area, and is the complete civic ideal.

The city was rendered a "unity in itself," not only by its platform, but by the massive fortification walls laid out foursquare upon its edge, and the aspect of completeness from without, that an unwalled or irregular city seldom possesses, was attained. The military wall thus shaped the city and had not, as in subsequent civilisations, the reverse effect. The filling in with streets ensued, and initially, through providing a really ample enclosure, there was neither stinting of spaciousness nor need for extra-mural suburbs. Grandeur of scale as a prime consideration generally procures other utilitarian advantages.

The Assyrian monarchs exhibited their glory through their architecture; they were not merely remorseless destroyers, but also enthusiastic builders. Conquered states were made into a wilderness to provide wealth and population for the cities of the victors. The kings incessantly built new palaces and temples, rivalling one another, like their imitators the Cæsars, in architectural luxury.

Sargon, the Shalmaneser who destroyed Sameria and Babylon, built a new capital to the north of Nineveh at Khorsabad, with a magnificent palace, and restored and enlarged the library at Calah (Nimroud).

His son Sennacherib, who attempted to be siege Hezekiah at Jerusalem, rebuilt Koyundjik with walls, quays and palaces, and the glories of the group of palaces of Nineveh with their sculptures belong to this king, whom the brick imprints describe as the rebuilder.

His son Esar-haddon, after his victorious sight of Memphis and Thebes, is credited with the building of thirty-six temples and ten palaces, including the great south-west palace at Nimroud.

The last name in this dominating Assyrian

succession is Esar-haddon's son Assur-bani-pal, the "great and noble Asnapper" in Rehum the Chancellor's indictment of Ezra's building, and the luxurious Sardanapalus of the Greeks. He re-invaded Egypt, sacked Susa, took Manasseh from Jerusalem, and built palaces at Nimroud and Koyundjik. Under this "Grand Monarque" the Assyrian Empire extended from India to the Ægean; its zenith was marked by buildings excelling in size, grandeur, and enrichment with sculptures, precious stones and libraries, and its sovereign's ideals by the legend on a statue at Tarsus, quoted in an after-age by its most distinguished citizen, St. Paul: "Let us eat and drink, for to-morrow we die."

The ideal of architectural splendour, stimulated by, if not originating with, rivalry and triumph over Egypt, descended from the Assyrian to the succeeding empires of the Chaldeans and of the Medes. Nebuchadnezzar secured the inclusion of his hanging gardens among the seven wonders of the world, and the residuary of the Egyptian dream is found at Persepolis in the palaces of Darius and Xerxes, erected subsequently to the Nile campaign of Cambyses in 525 B.C.

The Assyrian palaces reflect the imperial organisation which grouped all the departments of the government in the home of the despot. The multiplicity of well-ordered courts and chambers open from one another in groups, contiguous to but separated from the state and private apartments. "The satraps, deputies and the governors, the chief sooth-sayers, the lawyers, and all the rulers of the palace . . . which saw the king and sat first in the kingdom" are represented in the palace plan. The Palace of Westminster and the Cabinet of St. James's, with their up-to-date straggling and inchoate appendages, exhibit as historic fictions a condition that was concrete in the plan of the seat of this ancient world government.

The situation of Sargon's palace in the city of Khorsabad is at once central for business and retired for residence. It is erected on a square raised area within the platform of the town, and projects for about half its depth from the centre of one side of the wall of fortification; the royal apartments are thus external to the country on three sides, and are joined to the city only on one. This fortified palace enclosure is approached indirectly by an entrance from the city at the side with great ramps for chariots; the entrance court is the great gate of the king, the Sublime Porte, and the outer chamber of business. The part of the area next to the city contained the official courts, temples, and the site of the Ziggurat, or tower of the sun, usually at the side, as at Khorsabad, or as at Babylon in a separate enclosure: this consisted of a series of recessed stories encompassed by a sloping road to its lofty summit, and was the most important and characteristic feature, though scarcely possessing the architectural character either of a tower or pyramid. In the planning of the palace practical considerations appear to have been dominant, as nothing is sacrificed either to scale or to the effect of a long vista that would have been, however interesting on a plan, a nuisance and fault in the hierarchy of offices through which approach is made to the king's chambers. There is no central axis or central path, as in the Egyptian tomb and temple; those self-centred structures, idealistic and imaginative, are wholly different from the purpose and expression of the Assyrian government house, where the successful organisation of a world empire controlled the building fever of the monarch and discarded unpractical symmetry. The whole plan is strictly rectilinear, and the courts are skilfully arranged with connecting and private corridors; architectural dignity and emphasis is provided by sculpture for the pylons of the entrances and for the royal apartments.

We know but little of the planning of the houses of the city population, though their palm gardens, fronts of several stories and domed roofs are familiar from the sculptures, while the canals, aqueducts and carefully paved roads witness to the municipal services. The Assyrian civic centre, however, as highly developed in the magnificent government compound, evokes our jealous admiration, for no subsequent civilisation, Greek, Roman or modern—not even the Louvre at Paris which perhaps comes nearest in effect—has embodied with equal success the secret of its power in the plan of the heart of its capital.

BABYLON.

Babylon the Great inherited under Nebuchadnezzar the glory of Nineveh, but it had always been a city of sacred tradition, and revered as the seat of the primæval civilisation; more than any Assyrian capital it was ancient in its buildings and had commercial importance. Its history is an age-long conflict with its northern neighbour and master until the overthrow of Nineveh by Nebuchadnezzar's father in 604 B.C. Its supremacy lasted but little more than the reigns of three kings until its

capture, though not destruction, by the Persians in 539 B.C.

The importance of the business of the city is evident in the crowding of the houses and the reduction of open spaces, as courts and gardens became the prey of builders, even temples, like modern churches, being deprived of the dignity of space, and this continued to Roman times.

The city was enclosed by immense walls, on the great square Assyrian plan, with splendid gates. The Bab-ili palace citadel, or gate of the gods, lay within the angle of the walls between the river and the splendid Ishtar gate upon the sacred road—a position chosen manifestly for strategic rather than architectural reasons; it appears to have been the site of the ancient market-place. The genius of Nebuchadnezzar satiated itself in the architectural pride that the record of Daniel has petrified. He was walking upon the royal palace of Babylon. "The king spake and said, Is not this great Babylon, which I have built for the royal dwelling-place, by the might of my power and for the glory of my majesty?" It would seem that the implication of the boast of building the city for his residence lacks the justification that could be claimed by Sargon for Khorsabad, where the palace is both the heart and the head of the city plan. "The city of the king of Babylon's dwelling" is a rectangular fortress, consisting of large courts which extended the former palace of Nabo-Polassar in an elaboration of the Assyrian scheme. Besides the royal apartments, officers' residences and governmental offices, factories and warehouses and extensive substructures are included in the scheme; on the roofs of these were the world-famous hanging gardens.

Babylon was primarily a sacred city of temples. The great temple tower, the Ziggurat, of "The House of the foundations of heaven and earth," known to the Greeks as Jupiter Belus, stood within its own peribolus; adjacent to it, but separated by the road, was the Temple of Mar-duk, Nebuchadnezzar's peculiar cult. These and other great temples gave purpose and direction to the important processional road, which was both paved and raised. The road is parallel to the citadel, the temple enclosure, and the lines of the city walls which embank and fortify the river. It entered the city at the Ishtar gate, passed the citadel palace, and led to the Temple of the Tower, where it turned at a right angle thus separating it from the Temple of Mar-duk, and crossed the river by the bridge on stone piers to the considerable walled suburb on the western or right bank of the Euphrates.

The specially sacred character of the road, as leading to the Temple of Mar-duk, is recorded in inscriptions upon the edges of its paving. These are of white limestone and red and white breccia, in blocks 3 ft. square and 3½ in. thick. It appears to have been unused by profane chariots. This sacred way is named A-ibu-sabir, dedicated for the procession of Mar-duk, but it is not a temple avenue in the Egyptian sense, and its plan does not convey any clear purpose of a dignified passage from the gate to the temple entrance. It is more obviously a town-planned improvement skirting pre-existing sites, adapting existing streets on its flank, picking up temples *en route*, and encircling and passing rather than leading up to and revealing its goal. It has thus an affinity with any well-laid-out and reasonably imposed or widened modern thoroughfare. The road does not appear to have been decorated with sculpture, like the sphinx avenue at Karnak, though the Ishtar gate has splendid animal reliefs. The interest of the practical mind will, however, be compensated by its most carefully laid stone pavement upon an asphalt bed with an underbed of burnt brick.

This important city thoroughfare was only a pavement—a causeway—laid out on practical rather than on artistic lines, without a vista or direct termination. Its dedication to high objects is signified only by its surface; it had no superficial ornaments; it was designed ages before the modern discovery that the elevations of buildings abutting continuously provide a cumulative effect that imparts architecture to a street, and, though in an Eastern clime, before the ancient and beautiful adornments by colonnades for dignity and shelter or by the planting of trees were recognised and employed.

The glamour of the history, wealth and buildings of Babylon attracted and retained the Greeks; it became the world capital of Alexander, to which he returned and where he expired, and it survived him to impress the Roman imagination, and to find the mountainous brickwork of the walls and gates of its citadel repeated and perpetuated in the masses of the Imperial Thermæ. If we are in any way conscious of the effect of ancient Rome or modern Paris, in part or whole, upon our own ideals of civic architecture, it should not be impossible to place Babylon in its due relation to those of Alexander or of the Imperial Cæsars.

PERSIA.

The great era of the Indo-European Persian Empire covers the two hundred years from the capture of Babylon to Alexander, excluding from consideration the great exception of India. These centuries close the ascendancy in civic architecture of the East, and open the way for the Western art of Aryan Greece and Rome.

The scale progressively descends again with the advance of time, largely affected both by limitations of the building material and by the inferior constructive genius that this involved; but the glamour of Thebes was still powerful.

The Persians built no temples; their architecture only multiplied palaces, the kings maintaining the Assyrian habit of rivalling the dwellings of their predecessors in spacious sumptuousness and in gardens, pools and brillance of colour. The title "The Great King" expressed the sense of world-empire that ensued on the subjugation of Babylon by Cyrus in 539 B.C., and of Egypt by Cambyses shortly after. This is reflected in the building of Darius at Persepolis in 521 B.C.; upon the same platform his successor Xerxes emulated him in a building which exceeds the area of the hypostyle hall at Karnak; besides unascribed buildings, four kings have left identified signed structures upon the same royal stage.

The great Assyrian system of platform erection is maintained, but constructed of masonry. The beautiful feature of a great frontal royal staircase is introduced, well planned and decorated with ascending figures carved on the balustrades and spandril walls, ramps for chariots being provided at the sides. The palace halls rose upon further platforms with wide direct flights of steps. The majestic effect of an arrangement of ascending ground levels, regularly treated, is a new contribution to the materials of design, and first appears in Persian architecture.

At Persepolis the platform of the palaces is an immense square that surmounts the site of the city, projecting from a background of mountain rock. Upon it the square palace halls, which are detached from each other, are regularly placed as to aspect, but are not planned upon an axis or definitely grouped. The propyleum, which has gigantic sculptures of winged creatures, is not central to the great staircase; the buildings are of immense scale and grandeur, the hall of Xerxes being 350 by 300 ft., with seventy-two columns, the loftier series being 67 ft. in height. The whole effect is that of garden pavilions disconnected, but of grand scale and picturesque grandeur. Polyclitus, the Greek historian, says of Susa: "On the summit of the mound every king builds a separate palace for himself, with treasures and stores, and a pile of buildings set apart for receiving the tributes levied in his reign, to be kept as a monument of his administration." These tributes were levied in kind as well as in gold and precious stones—stupid stores, which fell as welcome prey into the hands of the historian's master, Alexander.

The Persian idea is a deduction both in plan and columnar treatment of Egyptian and Assyrian types: the conquerors thus embodied a permanent result of their campaigns. The absence of fortification walls to the palace area and of temples upon it releases and unifies the royal capital and partly approaches the less idealistic and more utilitarian circumstances of modern civic architecture, though on a very different scale.

Before altering the Eastward direction of our historical review, which with Alexander has reached the region of the Indus, the responsibilities of England in the regions beyond should not be wholly overlooked. In India, by slow and sure conquest, an architectural heritage has become our possession that is too little understood. James Fergusson, the architectural historian, remarks that "In India the employment of half the population in agriculture suffices to feed the remaining half, who, having neither manufacture nor commerce, found employment in temple building," and he compares these conditions with the state of Egypt under the Pharoahs, and with the resulting extent of their architectural output.

The great temples of Southern India have plans that are important to the study both of historic planning and of dignified design. These Dravidian temples of an age-long worship, are large rectangular enclosures, comparable in form, in extent, and in the lavish expenditure of material and of workmanship with the derelict temples of Egypt and the Assyrian palaces. They have pylon-like Gopura towers, porticoes of a thousand columns, porches, courts and pools, and employ a central axis in the plan. These Far Eastern plans suggest a universality of idea that only finds expression upon the scale of civic architecture. The spirit of these buildings being essentially Oriental, the constructive and æsthetic principles stagnate and do not fructify; but they are unrivalled in extent, and they are not useless as examples

of planned effect, if we have in mind that the area of an European or American town—our subject-matter in civic architecture—will surpass any of them in size.

(*To be continued.*)

TANNING MATERIALS FROM BRITISH MALAYA.

Some interesting particulars are given in the *London and China Telegraph* of the production in the Malay Peninsula and the adjacent islands of gambier, cutch, and areca nuts. Gambier is sold in bales and in cubes, the trade in bales being chiefly with European countries and the United States of America, where it is used in tanning. The statistics of the Straits Settlements show that the total value of gambier imports (in bales) from the Malay States, British North Borneo, and Netherlands India amounted to £208,060 in 1913, £170,234 in 1914, £293,317 in 1915, and £251,874 in 1916 (nine months). This was re-exported, and the destinations of exports are given below, together with the total values for three years :—

	1913.	1914.	1915.
Total value . . .	£214,535	£198,404	£300,261
United States . .	80,389	63,032	97,230
United Kingdom .	40,901	55,639	123,292
Belgium . . .	32,996	22,182	—
France	31,812	24,912	66,430
Germany . . .	7,839	8,570	—
Russia	6,774	7,770	2,075
Austria-Hungary .	3,817	3,755	—
Spain	2,784	1,674	—
Italy	2,355	5,181	6,868
Denmark . . .	1,312	2,781	—

In nine months of 1916 the total value of bale gambier exported from Straits Settlements ports was £267,186.

There are several varieties of gambier included under the heading of "cube." Primarily, they are used for chewing with the betel nut and sirih leaf amongst Oriental races, and this accounts for a considerable interchange of trade in the Archipelago. Of the Asian countries, British India is the best customer of the Straits, the gambier being used, as in Malaya, for chewing. In Europe, America, Australia, and South Africa, it is used for tanning. This preparation being more expensive than bale gambier, leads to the supposition that it is bought in Europe because a sufficient quantity of bale gambier is not available ; possibly, also, because it is of a purer quality. The total value of exports of cube gambier for four years is given below :—

1913	£165,031
1914	150,723
1915	153,431
1916 (nine months)	158,368

The principal purchasers were as follows, details for 1916 not being available :—

	1913.	1914.	1915.
British India . .	£61,139	£45,280	£68,768
United States . .	27,173	27,840	13,279
Netherlands India	17,894	31,023	18,533
Belgium . . .	13,349	7,677	—
Japan	8,312	2,131	2,112
United Kingdom .	7,945	18,151	32,432

Much more valuable is the trade in areca (or betel) nuts, which is, however, confined almost entirely to Asian countries, where it is used for chewing with sirih leaves. It is strange that there is no record of the export of this product to Europe and America from the Straits Settlements, for it is known as a component in medicines, tooth powder, etc., while the astringent qualities of the areca nut suggest its use in tanning. The areca nut is classified under the heading of "spices." The total value of the exports of areca nuts for four years is given below :—

1913	£1,010,211
1914	1,074,487
1915	1,267,813
1916 (nine months)	574,370

In this connection mention must be made of cutch, a product of the mangrove bark used for the tanning of hides, which is a local industry of considerable magnitude. Cutch is imported into the Straits Settlements mainly from Brunei and Sarawak, in the Island of Borneo, the values of imports and exports being :—

	Imports.	Exports.
1913	£30,337	£40,638
1914	33,569	37,918
1915	46,404	46,935
1916 (nine months) . . .	25,727	24,370

It is interesting to follow the changes that have occurred in the export trade since war broke out with the Central European Powers :—

	1913.	1914.	1915.
Germany . . .	£13,945	£326	—
United States . .	11,241	16,697	£6,928
United Kingdom .	7,089	12,420	20,709
Denmark . . .	4,638	—	2,141
Spain	1,245	2,332	—
Japan	832	694	1,965
Russia	163	396	4,581
Belgium . . .	—	1,420	—
Austria-Hungary .	—	653	—
France	—	606	2,695
Italy	—	490	991
Hong-Kong. . .	—	—	5,729

From the above statistics it would appear that this raw product, like many others produced within the British Empire, need not seek its market in enemy countries, but can be utilised in the Mother Country. It is, besides, a trade that might easily be developed, for there are large tracts of mangrove forests in Malaya awaiting exploitation by enterprising capitalists.

MAPLE-SUGAR INDUSTRY IN CANADA.

Canada, as a whole, produces annually, according to recent statistics, about £400,000 worth of maple products. Of the total yield during the five years 1908–12 the United States took 99 per cent. of the sugar and 50 per cent. of the syrup. In that period the aggregate export was 8,685,000 lb. of sugar and 20,000 gallons of syrup, the Province of Quebec being the chief producer.

In the Maritime Provinces, the value of the maple tree, save as a factor in the lumber industry, has hardly yet begun to be appreciated, and the making of maple sugar and syrup has never been undertaken in a systematic manner. Nevertheless, there are a few farmers who find the unfelled maple a source of profit. One of these has furnished to the U.S. Consul at Moncton, New Brunswick, ; the following particulars with regard to the maple areas and the making of maple sugar and syrup in the county of Cumberland (Nova Scotia).

The Cobequid Mountains, from near Parrsboro to Londonderry and Westchester, extend for about forty miles, with an average width of hardwood lands of perhaps fifteen miles. Of this hardwood it is safe to say one-third is maple. There are probably not more than one hundred sugarhouses in this whole area of 600 square miles. Practically all of these are equipped with modern evaporators. An outfit of buckets, tanks, evaporator, and buildings will cost from £80 to £120 for woods of 1,200 to 2,000 trees (a fair average in the county). In normal seasons the yield is about 1¼ lb. per tree, or 1,500 lb. for 1,200 trees. At the same ratio one hundred farms would produce 150,000 lb. of sugar.

The Nova Scotian maple sap is made into hard sugar, cream sugar, wax and syrup. Compared with Quebec's sugar woods, those in Nova Scotia do not yield as much per tree ; but whether this is due to the soil and the size of the trees has not yet been determined.

DRIED VEGETABLES.*

[In view of the steps which are now being taken by the Food Production Department to secure works in various parts of the country for the drying and pulping of surplus fruit and vegetables, it is believed that the following article will be read with special interest. To deal immediately with the pulping of plums, centres already exist, or will soon be opened, at Cambridge, Bewdley, Pershore, Cheltenham, the Harper Adams Agricultural College in Shropshire, Maidstone, Sittingbourne, Marden, and Chester. For the apple crop pulping stations are being established, or are completed, at Plymouth, Totnes, Crediton, Newton Abbott, Tiverton, Bridgwater, and Wedmore, near Cheddar. Drying centres so far established include Cheltenham and Pershore, and two other stations will be opened shortly in Worcestershire. Every county where intensive cultivation is practised will be covered.]

A new method for conserving vegetables by drying has recently been perfected by three Americans, Messrs. Waldron Williams, Woodford Brooks, and Dr. F. G. Wiechmann. The system is based on the fact that the micro-organisms which promote fermentation in vegetable matter depend upon moisture in order to live and propagate.

The problem, therefore, narrowed itself down to finding a way of dehydrating the vegetables which were to be preserved.

The greatest difficulty encountered was not in abstracting the water from the food products, but in preserving intact their cell structure so that their original food value would not be lost. After more than five years of experimentation, the inventors claim that this has been accomplished. It is now possible to reduce the percentage of moisture in vegetables to well within 12 per cent., by which process the development of bacteria is prevented.

The vegetables are first sliced and then brought into contact with heated air currents at relatively low temperatures, which serve to draw out, absorb and carry off the moisture in sliced vegetables while leaving them otherwise absolutely unimpaired. The vegetables are first cut up, but not parboiled or in any other way treated, so that their flavour is not spoiled. Then they are subjected to the new moisture-extracting process.

The volume of the air currents and their temperature can now be controlled to a nicety, as a result of long and exhaustive investigation. The time required to dry farm products depends wholly upon the vegetables dealt with. The period of treatment ranges from two hours to about five : this can be readily appreciated if the varying moisture content of the different vegetables is taken into consideration. For instance, fresh beets contain 87 per cent. of water ; cabbages, 91·5 per cent. ; onions, 87 per cent. ; potatoes, 78 per cent. ; and tomatoes as much as 94·3 per cent.

The greater the volume of water present the longer the drying operation must be maintained, in order to reduce the moisture content to the desired minimum and at the same time dry the vegetables uniformly.

Furthermore, the developers claim that products dried according to their system can, in large quantities, be sold at a lower price than the actual retail market price of green vegetables. This is due to the reduction in weight and volume of the products, and the consequent reduction of

* Extracted and condensed from an article by Leigh Danen in the *Popular Science Monthly*, New York, of May, 1917.

freights. They are of the opinion that fresh vegetables will be formidable competitors of the dried products only in fat years. At such times, however, vegetables are purchasable at a low figure, and the surplus will in all probability be dried to maintain a general balance in the green foodstuff market.

Among the many products which are being successfully dried at present, and which otherwise would go to waste, are potato culls—that is, potatoes which have been injured in digging, and therefore are below market standards. At least 10 per cent. of the potato crop falls into this class. This percentage is now being dried and converted into potato flour.

Windfalls in fruit offer another important field for conservation. The market usually insists upon hand-picked fruit. The loss in this respect alone is said to amount to more than 50 per cent. of the total growth. Windfalls are being dried at the present time so that they can be used in many ways. Powdered dry orange is as fragrant as the fresh fruit. So also are a number of other fruit flours.

A pound of dried mixed vegetables, made up of carrots, turnips, onions, cabbage and potatoes, prepared especially for soup, is sufficient for sixty or more adults. A barrel of the same vegetable weighing 100 lb. provides enough soup stock for nearly six thousand persons. The raw vegetables which go to make up this mixture before drying fill thirty barrels and weigh in the neighbourhood of 1,500 lb.

The food ratio between the dried and the original green vegetables is as follows: Potatoes, 1 pound to 7; cabbage, 1 to 18; onions, 1 to 13; spinach, 1 to 14; carrots, 1 to 12; and turnips, 1 to 13.

Drying establishments have already been erected and are now in operation at Middle River, California; Webster, New York; and Bound Brook, New Jersey.

THE AGRICULTURAL RESOURCES OF INDO-CHINA.

The *International Review of the Science and Practice of Agriculture* publishes an abstract of an article on this subject by M. H. Brenier, which appeared in the "Bulletin de la Société d'Encouragement pour l'Industrie Nationale."

Forest Products.—Though there are possibiliti s of opening up a considerable trade with China in the hard woods, at present there is no timber in Indo-China suitable for export to the European markets with the exception of "lim" (*Erythrophleum Fordii*, Oliv.), which is the material used for wood-block paving. Exports of forest products consequently consist almost entirely of by-products, the principal ones being: cinnamon; "cunao" (tubercles of the Discoriaceæ family, from which a dye is obtained); cardamoms (fruits of several Zingiberaceæ); benzoin; gutta-percha; sticklac; rattans for fine canework; palm wood for umbrella handles; vegetable lac (obtained by tapping trees of the Anacardiaceæ order); oil-seeds of *Calophyllum Inophyllum*, Lin., *Camellia drupifera*, Lour., and *Garcinia*; "abrasin" (a drying oil, probably obtained from *Aleurites montana*, Wils.); camphor; resin (from *Pinus Massoniana*).

Mangroves abound on the coast, and might be made to produce considerable quantities of bark of an exceptionally high tannin content, some samples having yielded up to 24 to 25 per cent. of tannin.

Animal Products.—It would probably be possible to develop an export trade from Cambodge and Southern Annam. Exports of raw hides had already reached 3,000 tons in 1913.

Food Stuffs.—After Burma, Indo-China is the most important rice-exporting country in the world, and, judging from the results obtained at the Experimental Station of Buitenzorg (Java), the production could be raised 50 per cent. by the use of improved varieties. Maize is now being grown for export, and an experimental ground has been set aside in Tonkin to investigate problems in connection with this crop. Small quantities of manioc and arrowroot are put on the market and could well be increased. Various kinds of pulse crops have been tried with success in Tonkin, the most popular at present being gram (*Cicer arietinum*).

Tropical fruits give promise of great future developments. With cold storage facilities, mangoes, mangostans, and pineapples could easily be put on the European markets, while a profitable commerce could no doubt be established in preserved papaya fruit (valuable for its peptic ferment papain) and dried "letchis" (*Nephelium Lit-Chi*). Coffee and tea have been successfully planted and may become important in the more or less remote future; but cocoa is at present almost unknown in the colony, though suitable localities for its growth exist in Cambodge around the Gulf of Siam. Pepper is already being exported in considerable quantities, and so is cane sugar, though the latter industry is not in a very flourishing condition, its only experimental station (in Central Annam) having been recently shut down.

Fibres.—Cambodge cotton is of a good fine quality, though not up to Louisiana varieties in length of fibre and tensile strength. It is all exported to Japan. Good progress has been achieved in the silkworm industry, and Tonkin silk now competes with Canton products on the European markets. The Experimental Station at Phulangthoung distributes selected grain from which yields of 1 lb. of silk per 13·5 lb. of cocoons have been obtained, or about twice as much as the native varieties produce.

Jute has been given a long but unsuccessful trial in the colony, ramie (*Boehmeria nivea*

and *B. tenacissima*) is found sporadically, and *Hibiscus cannabinus* is indigenous to the country, but its cultivation does not offer commercial openings at the moment. Kapok is obtained from *Eriodendron anfractuosum* and *Bombax malabaricum*, and is exported together with coir.

A certain amount of material is sent to Europe for the rush and cane industries—*i.e.*, various rushes, rattan canes, and the leaf fibres of palms (*Livistona sinensis*, *Chamærops*, etc.). Bamboo pulp for paper-making is now being manufactured at Vetri, a place situated at the junction of the Red and Claire rivers.

Oils and Fats.—Copra is produced in Cochin-China, ground-nut in Central Annam, and castor-oil seed in Tonkin. The colony also exports sesame seed and hevea seed, which contains about 42 per cent. of a drying oil somewhat similar to linseed-oil. There are districts in Upper Tonkin where hemp and colza could no doubt be grown with success.

Various other Products.—The most important of these is plantation rubber. In 1913 as much as 29,300 acres was under heveas, representing capital sunk to the value of £800,000. Exports in 1914 amounted to 180 tons.

Finally, as worthy of possible future developments, the following materials should be mentioned: tobacco, to be grown for the French Government monopoly; various essential oils and extracts, such as badian, citronella, vetiver, lemon grass, ylang-ylang, galangal, camphor, catechu, coca, and, lastly, agar-agar, to be obtained from certain seaweed beds on the coast of Annam.

CORAL PRODUCTION IN ITALY.

In an article in a scientific magazine published at Milan some interesting facts regarding coral are given, from which the following extracts have been translated by the United States Consul at Venice, a centre for the tourist trade in coral and shell cameos:—

Coral-fishing is carried on in Italy by fishers of Torre del Greco (Naples), of Leghorn and of Genoa. The manufacture of coral is confined to Torre del Greco. In other cities, such as Naples and Rome, only the mounting of coral in metal is done. The manufacture is entirely by hand, because this material, on account of its many irregularities, cannot be worked by machines. Coral, therefore, must be cut, sieved, bored, planed, rounded, and polished branch by branch. Each of these operations requires special workers (men and women), who use special instruments and work-tables. Thus cutting is done with files (triangular, flat, rectangular, and toothed) and with nippers. Sieving is done with special sieves, and distributes the cut coral according to size. The boring is entrusted solely to women. This work is done by means of a special type of small perforators. Levelling or planing is done by threading the bored corals on iron wire, laying them on a beam of hard wood, and passing over them, at a regulated pressure, a grindstone dipped in water. This work is also done solely by women. Afterwards the coral is rounded or turned, either at the grindstone, if the edges alone are to be rounded off, or with a file, if the so-called *pallini* (small balls) are desired.

For other objects, such as buttons, pendants, horns and reels, much the same processes are employed, with some omissions. The bars, for example, do not require boring; the horns and buttons do not need levelling. Coral may be worked with the chisel to make cameos, flowers, animals, and lettering. In this case the work of reducing its thickness is limited to the cutting and the grindstone wheel.

Polishing the coral follows immediately the work of the file or chisel. Then it is a matter of polishing either a quantity of coral, uniform and of medium size, or special pieces such as penholders or cameos. In the first case a quantity of coral is put in a small bag of strong raw linen together with crushed pumice-stone, and the bag is shaken in a special tub with a hole for drainage under a small column of water. When the coral is well pumicated it is washed and passed into a clean bag. Instead of the pumice the so-called *pulimento* (red or white) is used, and the former operation is repeated, first without water, then with a little, and finally with much water, when the coral has become brilliant.

If a single piece is to be polished, the process used is that for polishing shells, by means of finely powdered pumice-stone mixed with common oil. The grease is removed by soap and water, *pulimento*, or common chalk with sulphuric acid.

The coral trade of Torre del Greco branches out everywhere, especially to India—where Calcutta has been for very many years the largest coral market—to the United States, to Russia, and to Turkey.

OUTPUT OF QUININE IN MADRAS PRESIDENCY.

The 1915–16 Report on the Government cinchona plantations on the Nilgiris Hills in the Madras Presidency shows that the outturn of quinine during the year was 32,688 lb., as against 29,422 lb. in 1914–15. The quality was slightly inferior to that of the previous year, owing to the poor quality of locally purchased bark and the decreased yield of Java bark, which had been some time in stock. The advance in the price of bark raised the average manufactured cost of a pound of quinine from 10*s*. 9*d*. to 12*s*. 4*d*. Medical depôts pay 22*s*. 6*d*. a pound, but Government institutions, Native States, local fund hospitals, and municipal dispensaries

obtain it at prices ranging from 17*s.* 6*d.* to 20*s.* 6*d.* a pound, according to the quantity taken.

A total of 49,681 lb. of quinine sulphate was issued during the year, as compared with 41,865 lb. in 1914–15. This increase was due, it is stated, to large demands from the medical stores of Madras and Bombay; but the Central Provinces and certain Native States, especially Rajputana, also purchase considerable quantities. The Government furnishes to post-offices seven-grain packets of quinine, which are sold for a farthing each, and are thus within the reach of the people of the country generally. The department is now starting the manufacture of quinine tabloids.

According to a report by the United States Consul at Madras, there are two centres of the quinine-manufacturing industry in India—the Nilgiris Hills, in the Madras Presidency, and Darjeeling, in Bengal. The possible and, on occasion, the actual annual output of the latter place is about 50,000 lb. of quinine. In both localities a portion of the area under cinchona is owned by coffee or tea planters, and the bark they produce is either sold to the Government or exported.

Several species of cinchona are cultivated in India—namely, *Cinchona succirubra* (red bark), *C. calisaya* and *ledgeriana* (yellow bark), and *C. officinalis* (crown bark). The commonest species in Darjeeling is *C. ledgeriana*, and in Southern India *C. officinalis*. A hybrid form is also largely grown, and is said to yield a good bark. At the Government factories both cinchona febrifuge and quinine sulphate are made. As a result of the acclimatising of the cinchona plant in India, the annual imports of the drug on behalf of the Government have been discontinued. In Southern India the three Government cinchona plantations cover an area of 1,793 acres, of which 1,149 acres are under cultivation. The acreage under cinchona in 1913 on private estates in Southern India was approximately as follows: Madras Presidency, 2,486; Travancore, 2,085; Coorg, 176; Mysore, 48; total, 4,795 acres.

The Government sources of supply are: (1) bark from its own plantations, (2) bark purchased locally, and (3) bark purchased trom Java, the last-named being considered of especially good quality. No bark was purchased from Java during the year 1915–16, but the other sources supplied 352,165 lb. and 318,958 lb. respectively. The amount supplied by the Government plantations was the result of an economical use of uprooted trees, almost all the plantation bark being taken from this source.

The exports of bark were: 3,290,236 lb. in 1899–1900, 1,579,498 lb. in 1902–3, and 494,587 lb. in 1906–7. These went almost exclusively from Southern India to the United Kingdom. Exports from the Madras Presidency in 1914–15 were 642,987 lb., all to the United Kingdom. According to statistics prepared in 1908, there were said to be in the world then eighteen quinine factories—five in France, three in England, two in Germany, one in Holland, four in America, two in India, and one in Java. The world's demands for bark, it is said, average 14,000,000 to 18,000,000 lb. Java planters produce about 80 per cent. of the world's bark, and the modern trade centres mainly in Amsterdam.

Cinchona plantations were started in India in 1862 from seed introduced from South America. Cinchona is grown from seed or propagated from cuttings. When the trees are fifteen to twenty-five years old the crop is harvested, and this may be done in several ways. The trees may be copsed, in which case fresh shoots spring up and are allowed to grow, and these in time are again copsed, and so on; or the bark may be shaved off the standing trees, as near the cambium as possible without injuring it. The bark quickly grows again if this work is done carefully. Finally, the trees may be cut down and all the bark stripped from them, the stumps uprooted, and the bark stripped from the roots. Plantations treated in this way give the largest yield of bark and can be replanted. The bark, however obtained, is dried slowly in the sun, packed in bags, and sent to the factory or market.

OBITUARY.

Alois von Isakovics.—Information has been received of the death of Mr. Alois von Isakovics, of Monticello, New York. Born at Prag in 1870, he was educated in Austria, and graduated from the Chemistry School of the University of Vienna. In 1886 he proceeded to America, where be became naturalised in 1892, and he established in New York City the Synfleur Scientific Laboratories, which were moved in 1903 to Monticello. Under his guidance the firm developed rapidly, and became well known as manufacturers of perfumes, soaps, fruit oils for the confectionery, candy and chocolate industries, etc.

Mr. von Isakovics was a member of many American and British scientific societies. He was elected a Fellow of the Royal Society of Arts in 1910.

GENERAL NOTES.

Aeroplane Engine Output.—The *Daily Telegraph* says, profiting by our experience, America is to produce vast quantities of standardised aeroplane engines. Where we and the French have had about fifty types of engine in use at the same time, the Americans are to be content with six varieties only. This will mean a vast economy, a saving of both time and money. Only

an engineer can realise what it means to have to provide merely the spare parts required for so large a number of differing types of engines. American engineers, with their genius for standardisation, have evolved a few types of engines that represent the very best practice of this country, France, and Italy. There engines are being produced in various motor-car manufacturing works, where not only is much of the plant of a kind that can be readily adapted to aero engine manufacture, but the whole works are planned with an eye to an immense and speedy output. Quite independently of America's help in this direction—and it is bound to be gigantic—we are proceeding to increase still further our aeroplane output in this country. The Minister of Munitions is responsible for the enlightening fact being made public that no fewer than 1,000 factories are engaged on aeroplane work in this country. He tells us, further, that so vast are the requirements of these factories that they will need "the whole of the alloy steel that England can produce," as well as all available supplies of spruce and mahogany, and concludes with the reassuring statement that, "despite the magnitude of the demands, all the needs of aeroplane manufacture will be met." In view of these facts, one cannot but wonder how Germany hopes to secure aerial supremacy when so large a proportion of the raw materials for aeroplane construction are overseas products, which cannot reach Germany now that America is in the war.

A Degree in Commerce.—The Court of the University of Edinburgh have issued an ordinance, published in the form of a White Paper, which states that the degree of Bachelor of Commerce (B.Com.) may be conferred by the University. For the purpose of advising the University authorities on matters connected with the degree, the Court may from time to time appoint an Advisory Committee of persons experienced in commerce or industry, to be called the Advisory Committee in Commerce. If it be deemed expedient, it shall be in the power of the University Court, after consultation with the Senatus, to create a Faculty of Commerce, and to regulate the constitution thereof as regards composition and powers.

Sugar Production in Java.—The British Vice-Con ul at Sourabaya reports that the production of sugar in the Island of Java in 1916 amounted to 26,408,100 piculs,* as compared with 21,178,700 piculs in 1915 and 22,655,274 piculs in 1914. It is estimated that the area under cultivation this year will be slightly larger than in 1916. Prospects for 1917 are favourable; the coming crop looks well, and, given good weather conditions, shou'd be fully equal to that of last year. During 1916 trials were made with electrical ploughing machines, imported specially from the United States; but, as labour was more plentiful than in 1915, only lukewarm interest was displayed by planters in these experiments. Exports of sugar from Java from April 1st to December 31st, 1916, amounted to 1,234,200 tons, as compared with 1,152,300 tons and 1,018,200 tons during the corresponding periods in 1914 and 1915 respectively. The principal shipments during 1916 were made to the United Kingdom (537,800 tons), British India (314,100 tons), Hong-Kong (104,600 tons), and France (64,700 tons). It is estimated that at the end of 1916 about 2,000,000 piculs of sugar stored in Java remained still for disposal. Owing to the difficulties experienced in shipping other Javan produce, there is a strong demand for storage room, and, if shipments are not effected on a larger scale before the new crop comes in, the problem of storing the sugar will not be an easy one.

* 1 picul = about 133 lb.

Vegetable Dye in Korea.—H.M. Consul-General at Seoul has forwarded particulars regarding the production of dyestuffs in Korea from the leaves of a species of maple tree, known to Koreans as the "shinnamu." This tree is very common throughout Korea, and, according to the Director of the Central Technical Institute of the Government-General of Korea, is not found elsewhere, except to a certain extent in that part of Manchuria immediately to the north of the Yalu River. The official referred to states that if the dye should prove of commercial value, it could be produced in very large quantities in Korea. The cost of production, according to the same authority, is approximately 25 sen (about 6*d.*) per lb. With colours obtained from the "shinnamu" extract cotton goods can be dyed black, indigo, dark grey, grey, and khaki. In dyeing silk and pongees, black only can be utilised, and the chief value of the extract is for loading purposes, silk yarns or materials becoming over 30 per cent. heavier after treatment. H.M. Consul-General has also forwarded a sample of the "shinnamu" dye, together with samples of cotton yarns dyed with it in four colours. Particulars of the methods of using a yellow or khaki dye produced in Korea from the flower of the "enju," or "pagoda tree," have also been received from H.M. Consul-General. This tree is said to be very common both in Korea and in the districts of Manchuria immediately north of the Yalu River. Silk, wool, and cotton are all susceptible of treatment with this dye, a sample of which, together with specimens of various threads and yarns treated with it, have been furnished by the Consul-General. The above-mentioned particulars may be consulted and the samples referred to inspected by British firms interested at the Department of Commercial Intelligence, 73, Baisnghall Street, London, E.C. (2)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

EXAMINATIONS.

The results of the Stage I. (Elementary) Examinations, which were held from May 14th to the 23rd, were sent to the centres concerned on the 21st inst. The results of all three stages of both March and May examinations have now been made known.

In the Advanced Stage of the May examinations 2,021 papers were worked. 373 first-class and 950 second-class certificates were awarded, and there were 698 failures.

In the Intermediate Stage, 5,844 papers were worked. 911 first-class, 3,027 second-class, and 103 music certificates were awarded. The failures numbered 1,803.

In the Elementary Stage, 6,632 papers were worked. 4,316 passed and 2,316 failed.

The total number of papers worked in both examinations (March and May) was 24,281. Certificates were awarded to 16,006 of these, and 8,275 were failures.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

CIVIC ARCHITECTURE AND TOWN-PLANNING.*

By Professor Beresford Pite, F.R.I.B.A.

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Lecture I.—Delivered January 29th, 1917.

(Continued from page 667.)

Greece.

The earlier civilisation of the heroic age antecedent to Greek history was, roughly speaking, contemporary with that of Memphis and Thebes; but it is less easy to date. It is mainly represented to us by the recovered palaces of Minos at Gnossos in Crete, and by the remains of Mycene, Tiryns and Troy. The Iliad refers to Mycene as "wide-wayed," and also to the "well-builded streets" of "the wide-wayed city of the Trojans." Homer was not born blind, and his terms are necessarily relative to current standards in these matters; but the general results, unerringly revealed by excavation, seem to manifest that the town-planning ideals of the heroes were rather limited. The dominating necessity of defensibility, unconditioned by any artistic bias towards regularity, selected a site on a hill and enclosed it with heavy fortification walls, which are interesting in their cyclopean masonry, but rudimentary in architecture. Within, the king's citadel house had priority, and the sacred precinct of the temple was not, as in the later epoch, yet developed. The streets are in short lengths, abounding in change of direction, and have neither width nor manifest objective. We look in vain for direction to a centre, or for evidence of the civic instinct that plans both for convenience and dignity. A confusing littleness and a want of direct simplicity or concentration of idea mark the absence of design in the plan. The early Greek town was as stupidly practical and as helplessly limited by the feeble acceptance of awkward circumstances as the sphere of a modern British municipality.

The streets reflected the unpretentiousness of the house that avoided external display by closing itself compactly around the internal court or atrium. The attainment of an architectural value was not feasible in a street of houses without fronts. In consequence of this general domestic simplicity and modesty, we perceive but little of the outward aspect of Greek town life in the early epoch of kingly or patriarchal rule, for there was neither incentive nor example to develop architectural planning either in the houses, the narrow streets, or

* The course consisted of four lectures, delivered on January 29th, February 5th, 12th, and 19th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into six parts.

their agglomeration into a town. The architectural pre-eminence of the king's palace soon altogether ceased, and the scale of the larger house never attained dignity, though the portico of the entrance, the peristyle of the court, and the hall or megaron provided the fundamental roots from which grew the traditional temple design that, soon after the early age, fructified at Olympia.

The Cretan palace at Gnossos is earlier than the cities of the mainland, its plan is larger in feeling, simpler, and though involved is not too complicated to be legible. The palace lies upon a sloping but open site by the seaside, and as it is not fortified the design is freer than that of the Mycenean towns. The plan is quadrilateral and orientates. The western wall abuts on a paved square, probably a public agora; from the south-west angle a propyleum conducts, by an indirect corridor around the palace enclosure, through an entrance on the south side to the western block of the main quadrangle, which is about a double square, and the blocks on north and east have central passages into this court. Sir Arthur Evans, the seer and interpreter of this epoch-making excavation, discerns in the placing of these thoroughfare passages the embryo of the plan of the later Roman camp, the Cardo or main axis, the Decumanus crossing at right angles, and the minor parallels of the halls and smaller lighting courts. The whole is a developed domestic plan to which dignity of internal arrangement is imparted by a rectangular system and axial lines. The maze of walling that composes the basement storey of store-rooms and corridors is capable of resolution into a normally intelligible plan, and is not as labyrinthine—in the conventional use of this term—as a modern network of passages and small rooms. If this palace was the Labyrinth, built by the ingenious architectural craft of Dædalus, founder of the Flying Corps, Sir Arthur Evans will justify his belief that the name is connected with the cult of the Labrys, or double axe, representations of which abound on its walls. This Minoan palace is not only one of the earliest, but is one of the most considerable house-plans of the Greek world. Though not comparable with those of the Eastern empires, it is an example of the scale of primitive domestic splendour in Greek lands—a type, moreover, in spite of its relative modesty, that the zeal of later philosophers and writers was proud to disown.

The civic history of Athens is long and varied, though the culminating period of its art and political eminence was short and central. The original settlement on this very beautiful site consisted of a pair of villages grouped on low hills at a safe distance from the bay, under the shelter of the rock, the table-like surface of which provided a site for the citadel of refuge and for the primitive temple. The triumph of the little City State over the great and aggressive kingdom of Persia was followed by the re-erection of temples and public buildings at the period of the acme of the arts; in the haste of re-fortification, and in jealousy of the activity of Sparta, the old narrow and crooked streets were re-adopted, and no attempt was made to plan the city upon geometrical lines. The Parthenon, however, was replaced upon a new foundation, which was not, as its predecessor, upon the axis of entrance from the Propylea.

Though the port of the Piræus as well as colonial towns had by this time become the subjects of a town-planning architecture, there was no vision of a capital city ideally planned. There are probable indications of a regular earlier street arrangement upon the Acropolis, but the great elevation and inaccessibility of this majestically isolated rock had caused the city to develop in the vales of the north and west, where the streets wrestled with the central cliff within a straggling wall surrounding the whole area. It must be borne in mind that the Acropolis was a factor sufficient to mar the design of any comprehensive town plan, and the modern Athens, which has a city plan of many admirable points, quite wisely did not attempt to make this a central element.

It was the avowed policy of Pericles to emphasise the glory of the principal city of the Ionian confederacy by devoting public wealth to its architectural adornment: this was concentrated upon the famous buildings within the temenos of the Acropolis; but the site-planning of these monuments, hampered doubtless to an extreme by sacred limitations, reveals no great conception of combination in architectural effect; the academic question of a design in their accidental picturesqueness should need no discussion, for affectation of this sort was alien to Greek thought. In the ensuing period of political decline the city was administered solely in the interest of financial economy—a circumstance that for three or four centuries continued to stimulate a remarkable flow of private liberality to the enrichment of the city. Athens, always conscious of her history, possessed in her jealousy of civil liberty one of the secrets of perennial life and spirit. This civic pride,

which may in part be paralleled in Mediæval Florence, kept the reputation of the city vivid long after its independence had expired. Leake says, "No city ever enjoyed such a course of prosperity after the loss of its political importance."

Athens, like other capitals, multiplied public offices demanding sites that were provided on the sides of the Acropolis towards the country. The Agora, or forum, commenced inside the northern, or Dipylum, gate, in the potters' quarter, or Ceramicus. It was divided into markets by streets and bazaars, mostly named from the commodities for which they were used—as women's goods, ready-made clothes, vases, *i.e.* crockery, butchers' meat, fish, flour, books and slaves. Porticoes and stoas with painted decorations were added from time to time, and statues and avenues of plane trees. The civil life is illustrated by the Prytaneium, "the hearth of the state," in which were deposited the written law-tablets of Solon. This was an extensive building where the city fathers, to the number of 500, met and dined at the public expense; behind was a place significantly called "the plain of famine." The annual senatorial business was conducted in the Bouleuterium; near by the fathers sacrificed in a large circular building, or tholus, and statues of the ten heroes of the tribes were provided for notice-boards. The artizans had a council house near the gate; there was a sanctuary for the meetings of each of the ten tribes, the Lyceium for archives, libraries, a mint, warmed shelters for the poor, many baths, large palæstræ for the training of youths, and a house for the rehearsal of tragedies. To the north was the gymnasium and the gardens of the old Academy surrounded by high trees, and to the south, having the beautiful prospect of the bay, the group of sites devoted to the arts, including the Odeium, from the earliest time devoted to music, the great open Cavea of the theatre of Dionysius and some subsequent fellows. To the south-west, set out on and carved out of the low hills, were the Pnyx, set apart by Solon for public assembly, and the open-air court of the justices of the Areopagus. The great stadium was situated on the further side of the stream of the Ilissus to the south-east. The street of the tripods wound around the base of the north-east cliff of the Acropolis, and is still marked by the honorary monument of the Choragus Lysicrates, revered for its proto-Corinthian order. Altars, sanctuaries and statues were plentifully distributed throughout the city, and a street of tombs, the pathetic beauty of which can still in some measure be realised, led northwards from the Dipylum gate.

The splendour of Athens was increased by the munificence of allies, conquerors and citizens in honour of her intellectual fame. Ptolemy Philadelphus (slayer of his brothers, founder of the library of Alexandria and father of the promoter of the Septuagint) bestowed a large gymnasium; the Attalid kings of Pergamos erected stoas and planted in the Academy; and Antiochus Epiphanes attempted the completion of the huge temple of Jupiter Olympius. The foreign Romans treated the city even better than her Macedonian neighbours in spite of all political follies: Sulla spared the town, though he dismantled the walls and carried the libraries to Italy; Julius Cæsar pardoned the living for the sake of the dead; to him, with Augustus and his son-in-law Agrippa, were due the still standing Propyleum of the Agora, a theatre near by, and other buildings; and Cicero and Horace are found among the administrators. The world-architect Hadrian was passionate in his Athenian zeal. He added another magnificent stoa to the Agora, the whole of which he enclosed; he restored the temples and completed the almost impossibly huge Olympeium; around this temple he laid out a suburb, named Hadrianopolis, that extended to the Ilissus and was entered through the archway that still bears the inscription, "This is the city of Hadrian, not of Theseus." Private benefactors emulated these imperial donors: Andronicus built the tower of the eight winds, still standing in the Agora, and the rhetorician Herodes, surnamed Son of Atticus, tutor to Marcus Aurelius, perpetuated the memory of his wife Regilla in the gift of an Odeium, a music theatre roofed with cedar, and bestowed marble seating on the stadium—a gift emulated and repeated a few years since by a Greek patriot.

Though the culminating era produced at home, and in the Hellenic colonies east and west, temples of incomparable beauty often placed upon marvellous sites, it developed no civic architecture. The intellectually noble Greeks accepted in their premier cities a standard of municipal art that was extraordinarily low. Demosthenes is a witness to, if not also a justifier of, the crooked and mean streets of Athens in praising the severely modest dwellings of the great citizens. Leake quotes Dicæarchus, of the same era, to the effect that the streets were so narrow and the houses so small and inconvenient, that a stranger suddenly

placed in the town would doubt that he was in famous Athens: idealistic Athens was, in this respect, little better than the proverbial Sparta.

Pericles could not, however, have been unconscious of the meanness of the crooked streets of the city, for he was concerned for the dignified laying out of the port. Grote (chap. xlvii.) writes: "It was seemingly about this time (443–442 B.C.) that the splendid docks and arsenal in Peiræus, alleged by Isokrates to have cost 1,000 talents, were constructed; while the town itself of Peiræus was laid out anew with straight streets intersecting at right angles. Apparently this was something new in Greece—the towns generally, and Athens itself in particular, having been built without any symmetry, or width, or continuity of streets. Hippodamus the Milesian, a man of considerable attainments in the physical philosophy of the age, derived much renown, as the earliest town architect, for having laid out the Peiræus on a regular plan. The market-place, or one of them at least, permanently bore his name—the Hippodamian Agora. At a time when so many great architects were displaying their genius in the construction of temples, we are not surprised to hear that the structure of towns began to be regularised also. Moreover, we are told that the new colonial town of Thurii, to which Hippodamus went as a settler, was also constructed in the same systematic form as to straight and wide streets."

It is a consideration of some interest that the geometrical speculations of Pythagoras, who had studied in Egyptian and Chaldean cities, were at the source of the town-planning theory and practice of his later disciple Hippodamus. The Pythagorean philosophy had its home in the flourishing Hellenic cities of Italy and Sicily, where free opportunity abounded for experimental development. The application of geometry to the street-plan of a city or acropolis, wherein the temples are necessarily and strictly related to astronomical orientation, seems natural; but it does not appear that the possibility of an alliance between scientific geometry and æsthetic architecture was yet realised. Another practical philosopher of this school, Empedocles, who lost his life exploring the crater of Etna, is credited with remedying the sanitary conditions of the marshy site of Selinus.

The lack of appreciation at Athens of system in the street-plan, or of an ideal of civic architecture, is also exemplified by the absence of co-ordination of separate buildings to gain cumulative effect. It may indicate reluctance, in a people devoted to liberty, to view life as a whole, and suggests, though it can scarcely be affirmed, that the intellectual and political freedom which is essential to the greatest art may miss its wide expression in civil architecture through failure to value communal interests, and by aversion from the discipline of its sanitary basis. The tyranny that could impose a great ideal and marshal the means for its achievement was as remote as the Nile or Tigris from the politics of the Ægean, and the mild combination of persuasion and compulsion, in which we generate our town-planning schemes and municipal hygiene and architecture, was yet to be evolved. Perhaps, also, the citizens of these wonderful republics were, like ourselves, too conservative of their private vested interests to endure the disturbance or expense of a fundamental building reform, or properly self-satisfied with the soporific beauty of their isolated famous temples, were perhaps justified by the easy excuse of an acropolis that forbade a theoretical town-plan, and by grave historical associations that must not be trifled with. The residential quarters—at least, of the more important Greek cities—were thus fully ripe for effective town-planning reform when the Macedonians took victorious possession of the fruits of the Egyptian and Mesopotamian civilisations in the fourth century.

Greek legislation and speculation, however, did not altogether overlook the regimen of towns. Mr. John Slater, in a paper read to the Royal Institute of British Architects, states: "There is no doubt that Solon's legislation dealt fully with servitudes and the rights of neighbouring owners. . . . There were officials in Athens who looked after public and private buildings, and special officers who had the care of walls, springs and boundaries, and, in addition, special officials whose duty it was to look after the public roads and private encroachments." Professor Haverfield has pointed out that the Agoranomi, who controlled the markets, and the Astynomi, who were in charge of the streets, do not appear in inscriptions until after 350 B.C.—that is, not before the Macedonian era. A prohibition which he cites of balconies and verandahs in Athens was probably due to the narrowness of the streets.

Aristotle, in the following interesting passage ("Politics," Book II. chap. viii.), describes the celebrated professional adviser, already mentioned, with personal touches that do not seem altogether strange to our own day: "Hippodamus, the son of Europhon a Milesian, contrived

the art of laying out towns, and separated the Piræus. This man was in other respects too eager after notice, and seemed to many to live in a very affected manner, with his flowing locks and his expensive ornaments, and a coarse warm vest which he wore, not only in the winter, but also in the hot weather. As he was very desirous of the character of a universal scholar, he was the first who, not being actually engaged in the management of public affairs, set himself to inquire what sort of government was best; and he planned a state, consisting of ten thousand persons, divided into three parts, one consisting of artisans, another of husbandmen, and the third of soldiers. He also divided the land into three parts, and allotted one to sacred purposes, another to the public, and the third to individuals." In Book VII., chap. xi., Aristotle again deals with town-planning as follows: "Both the city and all the country should communicate both with the sea and the continent as much as possible. There are these four things which we should be particularly desirous of in the position of the city with respect to itself: In the first place, health is to be consulted as the first thing necessary . . . It should next be contrived that it may have a proper situation for the business of government and for defence in war . . . In the next place particularly, that there may be plenty of water and rivers near at hand . . . As to fortified places, what is proper for some governments is not proper for all; as, for instance, a lofty citadel is proper for a monarchy and an oligarchy; a city built upon a plain suits a democracy: neither of these for an aristocracy, but rather many strong places. As to the form of private houses, those are thought to be best and most useful for their different purposes which are distinct and separate from each other, and built in the modern manner, after the plan of Hippodamus; but for safety in time of war, on the contrary, they should be built as they formerly were; for they were such that strangers could not easily find their way out of them, and the method of access to them such as an enemy could with difficulty find out if he proposed to besiege them. A city, therefore, should have both these sorts of buildings, which may easily be contrived if anyone will so regulate them as planters do their rows of vines; not that the buildings throughout the city should be detached from each other, only in some parts of it. Thus elegance and safety will be equally consulted. . . ." This argument may indicate a bias towards the Athens of his day. In the next chapter he continues: "As the citizens in general are to eat at public tables in certain companies, and it is necessary that the walls should have bulwarks and towers in proper places and at proper distances, it is evident that it will be very necessary to have some of these in the towers. Let the buildings for this purpose be made the ornaments of the walls. As to temples for public worship, and the hall for the public tables of the chief magistrates, they ought to be built in proper places, and contiguous to each other, except those temples which the law or the oracle orders to be separate from all other buildings; and let these be in such a conspicuous eminence that they may have every advantage of situation, and in the neighbourhood of that part of the city which is best fortified. Adjoining this place there ought to be a large square, like that which they call in Thessaly 'The Square of Freedom,' in which nothing is permitted to be bought or sold, into which no mechanic nor husbandman, nor any such person, should be permitted to enter, unless commanded by the magistrates. It will also be an ornament to this place if the gymnastic exercises of the elders are performed in it . . . There ought to be another square separate from this for buying and selling, which should be so situated as to be commodious for the reception of goods both by sea and land." After some further directions as to tables for public officials, Aristotle concludes: "It is by no means difficult to plan these things, it is rather so to carry them into execution; for the theory is the child of our wishes, but the practical part must depend upon fortune."

Reference has been made to the notoriously prosperous cities of Magna Græcia in Southern Italy and in Sicily, made rich by the fertility of the soil, the sweetness of the climate and by the African trade. The city of Sybaris, in the Bay of Tarentum, proverbial for luxury, was, before its destruction by its neighbour city Croton in the sixth century B.C., reported to be the largest in the Hellenic world—its walls being six and a half miles in circumference, besides extensive suburbs adjoining the river. Agrigentum, on the southern shore of Sicily, though second in size enjoyed, poetically and perhaps justly, the title of "the most beautiful city of mortals"—a qualification implying an Olympian ideal.

In such cities "the millionaires of the West surpassed the wildest dreams of the plutocratic oligarchs of the Mother-land." Selinus, the

westernmost of the colonies in Sicily, has been fully described by MM. Fougéres and Hulot. The Acropolis faces the sea, the site of the vast ancient town lying behind to the north. On either side is the river to the west and the naval harbour to the east, the Necropolis on the western height and the Agora on the eastern. The wonderful series of six temples is in two groups, three being on the Acropolis and three near the Agora. The site of the ancient town has revealed no street-plan, but within the fortified wall of the Acropolis one has been discovered that has remarkable affinity to the method of Hippodamus, though M. Hulot believes it to be contemporary with the temples which are a century and a half earlier, thus reminding us of the primitive street arrangement on the Athenian Acropolis. The walls of the Acropolis were planned by the general Hermocrates previous to the storming by Hannibal (408–9), when the city was dismantled never to regain greatness. Within the walls the area was laid out with a straight central thoroughfare on its long axis from the gate at the northern extremity to the sea front. The crossing streets forming insulæ are completely rectangular and simple, and have no conformity with the irregular shape of the site; they are not planned to the temples, but pass them on accidental though parallel lines. The plan is obviously a design, intelligent and practical, but without any relation to the effect of the magnificent temples of which the city was so justly proud, and it leaves us wondering at the opportunity for architectural planning yet to be discovered and ere long to be brought from the East.

Lecture II.—Delivered February 5th, 1917.

THE HELLENIC EAST.

The royal splendour of the East was in the landscape of Alexander's outlook; it reacted first upon those cities of the Eastern Mediterranean which expanded into new life after his death. Hellas had solemnly perfected her architecture without the luxurious worldliness of the East; she had rejected the megalomania of Egypt, and was unconscious of its effects upon the active and unrefined Assyrian and Persian characters; but now by conquest she entered into possession, at Babylon and Persepolis, of its architectural ideals in the dignity of great planning and the value of the disposition of site and mass. The beautiful architectural forms of Greek traditional attainment were now to be drawn with new impetus and ideals into combinations based upon the art of civic planning. We shall have nothing to observe, in our study of the many centuries under review, that is more stimulating or fruitful of result than this revelation to Europe of an Asia that had discovered and digested Egypt.

The Macedonian era, despite its great leader, brought to bear upon civic architecture the vitalising tradition of Hellenic civil liberty, and thus imposed a pause upon those immense works which could only be executed by enslaved populations, by the sacrifice of the resources of the State, or by the fruits of wars of depredation. The disintegration of the ancient tyrannies has destroyed the control as well as the resources necessary for the carrying out of plans of such vast scope as the foursquare city, or city of the palace, and civic art has been left to make its bricks without straw. Hereafter, with the partial exception of the productions of slave labour in Rome, European civilisation developed architecture upon a smaller scale.

The campaigns by which Alexander opened up a new world in the fourth century B.C., though inimical to the civic patriotism of Greece by the distribution of her intellectual wealth, gave to her what Findlay describes as "a degree of social authority over human civilisation" that still endures. Alexander's ideal was not that of a destructive Assyrian conqueror; it embraced a world government, the social order of which required the founding of cities peopled by means of his authoritative mixture of the Greek and Persian races. Royal cities, mostly bearing his name, were placed strategically upon commercial routes: of these Alexandria, Candahar, Herat and others remain to attest his prevision.

Through the wisdom of his father Alexander had been a pupil of Aristotle, and therefore not without a social doctrine that took account of town-planning and of architects. Systematic design and dignified character were essential to the new foundations; a new stimulus to magnificence of scale and impressiveness was derived from the conquered cities of Egypt and Mesopotamia, as well as the means for its exhibition from the treasures hoarded by the stupid policy of the Persian kings. Greek architectural art, within the limited concentration of its own historic lands, had attained a perfection. This was generally maintained as it expanded into the civic Hellenistic art of Asia and afterwards became universal in the Roman world, to descend to us in that Renaissance atmosphere in which, on a minor scale, our civil arts live

and grow. The circumstances and results, however, of Alexander's city founding were very different from the speculative squatting that so often determines the position of the towns in the modern world upon which commercial prosperity descends, magnifying them into graceless cities.

Vitruvius, the Roman architectural writer of the time of Augustus, in the introduction to his second book describes the interruption of Alexander's tribunal one day by the appearance of a handsome fellow crowned with poplar, anointed with oil, garbed only in a lion's skin, who introduced himself as Dinocrates, a Macedonian architect, desirous of submitting a scheme for carving Mount Athos into the statue of a man holding a spacious city in his left hand, and in his right a huge vase, into which should be collected all the streams of the mountain, which should thence be poured into the sea. Alexander inquired if the soil of the neighbourhood could yield sufficient produce for such a State, and, on learning that all supplies must be furnished by sea, dismissed the project, but retained the services of the architect for use at Alexandria, a site supported by the commerce of a land of corn. This legend contains the imaginative embryo of a city unified in an artistic idea, adapting a romantic site to its purposes, and in a measure typifies a Hellenistic ideal.

In the preceding epoch three towns in the island of Rhodes decided that it would be mutually advantageous to unite their corporations and to commission Hippodamus to design a new city—wiser in their generation than English triple townships. His plan conformed to the bay by a sensible abandonment of rectangular for radiating streets. A great reputation for civic splendour was thus procured, and in the ensuing century the Colossus that bestrode the harbour revived the dream of Dinocrates. The rival city of Halicarnassus, not far off, was also, in the middle of the fourth century, laid out by Mausolus upon a crescent bay. Vitruvius describes the site as resembling a theatre: the forum was in the lowest part near the quay; in the middle of the curve was the celebrated Mausoleum, erected by the disconsolate sister and widow who drank his ashes; on the central summit stood the Temple of Mars and a colossal statue, the landmark here, as elsewhere, dear to Greek sentiment; on the right eminence of the crescent there was the Temple of Venus; and on the left the royal palace with its secret harbour.

Alexander had preserved the city of Babylon as the metropolis of his Empire; but the division of his estate into monarchies provided new emulation in the capital cities of Lysimachus—at Ephesus the shrine of Diana, of the Ptolemies at Alexandria with the Library, and of the Seleucidæ at Antioch with its famous park.

The Agora now developed into a noble civic centre. The greater temples with their enclosures grouped or adapted themselves upon romantic sites, but neither the civil nor sacred buildings had an integral connection with or imparted dignity to the residential town, which seemed to be of little account. The dwellings of the citizens, whatever their increasing size and convenience, did not share in the architectural scheme of the town-plan. These conditions resulted from the character of the daily life of the inhabitants. The Greeks—for so we continue to name the dominant race—were a city-loving people unwilling to prefer the country, not like ourselves attempting to mix rural and town life, and they do not appear to have cultivated gardens generally with large lawns and flowers. The citizen went outside the privacy of his house atrium through the narrow streets to enjoy life in the porticoes around the Agora, to exercise himself in the gymnasium or baths, and to spend daylight in the theatre or stadium. A Greek city was more than a collection of streets of houses and shops with buildings of independent purposes — commercial, sacred, or governmental. The open spaces and their adjuncts together composed an amenity essentially civic and humane; the public buildings, the vessels containing the elements of daily civic existence, were linked with the Agora, in which was centralised the interest of the town-plan and life.

Ephesus and Pergamos—the former rebuilt by Lysimachus and the latter the seat of the royal house of Attalus, allies of Rome in its later conflict with Macedonia—both illustrate the growth of Hellenistic splendour in buildings and their arrangement, and its independence of the city plan as a whole.

The earlier Crœsus Temple of Diana at Ephesus was destroyed by an incendiary on the night of Alexander's birth; it was slowly rebuilt by the self-sacrifice of the citizens, who refused his proffer of the total cost of its reconstruction for the honour of inscribing Alexander on the pediment. The new town of Lysimachus was at the port about a mile distant from the temple, and it is said that he effectively cleansed the old quarter out of existence by an artificial

inundation. The Agora Civilis was on a great scale, having a pool in the centre, and surrounded by important buildings. Upon the central axis a gymnasium with surrounding colonnades was planned, and on the same line is the grand propylæum with flanking porticoes, giving access from a nobly recessed quay that opened on to the polygonal inner port. The scheme is thus an architectural arrangement of various units upon an axial motive grouping elements with artistic intention that may suggest a mingling of the Piræus with the Athenian Agora. Mount Coresus forms the background; out of its front to the Agora Civilis, to the right and left, are excavated the stadium and the theatre, probably the scene where, "after the manner of men," St. Paul fought with beasts. Gateways in the city wall on each side of the mount give access to the processional route to and from the Great Temple; but the roadway was irregular in form and without the stately architectural emphasis or direction that would have been imparted to it at Thebes or Babylon.

Pergamos stands between the earlier Hellenistic cities and the Roman era, and witnesses to the perception of the cumulative value of a series of grand buildings. The great open-air Altar of Zeus with its porticoes, celebrated for the podium of the Gigantomachia that for some years past at Berlin has been exercising a malign influence on national ideals, occupied the site of the original Agora; it stood in the centre of the arc of a crescent-shaped ridge forming the background of the town beneath. A series of monumental buildings, consisting of the temples, royal palace and library lined the crest of the hill; in the heart lay the cavea of the theatre with the great terrace below—a magnificent feature. The "massed formation" of great buildings for effect is attained here, probably without design, by the formation of the site; but it may well be considered a further step in the progressive revelation of the combined value of separate buildings in civic architecture as well as an emphatic reminder of the artistic value of a shapely site to a town-plan.

Rome.

The city of Rome was almost without architecture in the era parallel to the development and supremacy of Grecian art, during which its civil policy was attaining irresistible greatness. The original limit of the city on the Palatine Hill was square as the Pretorian camp and named Roma Quadrata. To the north-west on the peaks of the Capitol Hill, across the valley of the Velabrum, stood the Temple of Jupiter and the citadel. Between the mingled valleys of the Septimontium primitive settlements had combined around the open market space that was to become the civic centre of the world.

The shapelessness of this Forum Romanorum, the steep alleys ascending to the hill tops, over which the palaces spread their courts, the narrow straggling lane of the Via Sacra, all remained fundamentally incapable of effective reformation, and in strange contrast to the ideal which Rome uniformly imposed upon her daughters throughout the rise, continuance, and decline of the Empire. On the capture and destruction of the city by the Gauls in 390 B.C. migration to the site of Veii was proposed, but houses arose hastily and irregularly out of the ruins, as in London after the fire, and to this were due the eventual narrowness and crookedness of the streets of Rome, in spite of great efforts to remedy the fundamental disorder. By the time when the effective possession of the Hellenistic East made Rome the mistress of the world, the city had a congested population of about half a million, and it was no longer possible to avoid improvement.

Julius Cæsar, at great personal expense, expropriated part of the heart of the city for the erection of a forum with a central Temple of Venus. This work evidences a talent for organised planning which we may well judge to be characteristic. The forum is a rectangle, conformed externally to the surrounding irregular lanes by shops of varying depths; internally dignified colonnades surround the forum, three sides of which are thoroughfares. The axis is parallel with the Via Sacra and the Public Office or Curia; while the fourth side is a vertical continuation of the line of the Rostra. This new forum of Julius set a note in civic planning that is still dominant. Order was created upon an irregular site, and while adapting the existing conditions emphasised by means of its plan the interest of the historic elements of the older forum and of the Via Sacra.

Augustus enthusiastically and successfully followed Cæsar's example: he levelled a site for a new and larger forum to contain a temple to Mars the Avenger, planning its axis in continuation of the thoroughfare across the end of the forum of Julius and significantly dominated the vista from the scene of the assassination. To obtain sufficient space the base of the Quirinal Hill was levelled—the first of many drastic operations for extending the central area

of the city. Against this background the temple was placed, and the whole forum enclosed with an immense wall lined on the interior with a great porticus.

Succeeding Emperors for more than a century continued to develop the series of forums, closely packed together and surpassing each other in scale until the enlarged area extended from the Temple of Trajan to the Coliseum. Each forum constituted a public place with a central dominating temple or basilica, surrounded by colonnades or porticoes, out of which opened hemicycles and halls. A consistent parallelism in planning, maintained upon common axial lines, accumulated architectural effects by vistas that were designed with forethought and not left to romantic accident. It is difficult to describe the whole result otherwise than as a triumphal progress of civic architecture. The temples and basilicas are features, the triumphal arches and columns ornaments, but the forums themselves in their magnificent planning express the glory of the city in its public places.

An architecture of scenic grandeur based upon pure dignity of plan is here evolved that is a permanent contribution to art. It is intelligently adaptable and ingeniously inventive of grand motives, but always geometrical. It has a perception of geometrical planning that was undiscerned by the Greeks, though in its main elements recognised and used greatly by the Egyptians and less by the Assyrians, but was not applied in the Alexandrine cities to any serviceable extent. The unromantic but methodical Roman genius developed, or caused to be produced through the Greek slave-architect, a grandeur of effect, with a modicum of originality, on a scale that the idea of the Imperial Metropolis alone justified; and this architectural apparatus of Roman forums, in plan, form and details, remains the material and inspiration of the civic designer of to-day.

The scale of the metropolitan Coliseum and the splendour of the public baths is representative of civic life, and the competition of the Emperors in luxury is witnessed in the series of palaces rivalling the forums in magnificence. The plans have artistic suggestiveness, and are valuable to the architect in spite of the unhealthy atmosphere of selfish greed and glory in which they were generated.

Nero's works in preparing a site for his new palace and gardens produced a crisis. The city, elbowed out of the valleys around the forum, had grown irregularly, in narrow streets of lofty tenements, within the extended circuit of the walls down to the river and over the plain. Tacitus has given a description of the fire that raged for five days, leaving only four out of the fourteen quarters of the city intact. There was grave suspicion of Imperial incendiarism, for which Nero "punished, with exquisite torture, a race of men detested for their evil practices, by vulgar appellation commonly called Christians." The historian ("Annals," Bk. XV., xliii.) describes the proceedings for the rebuilding that followed: "The ground, which after marking out his own domain Nero left to the public, was not laid out for the new city in a hurry and without judgment, as was the case after the irruption of the Gauls. A regular plan was formed: the streets were made wide and long; the elevation of the houses was defined (Strabo says, that by an ordinance of Augustus no new-built house was to be more than 70 ft. high), with an open area before the doors, and porticoes to secure and adorn the front. The expense of the porticoes Nero undertook to defray out of his own revenue. He promised, besides, as soon as the work was finished, to clear the ground and leave a clear space to every house without any charge to the occupier . . . It was also settled that the houses should no longer be contiguous, with slight party-walls to divide them; but every house was to stand detached, surrounded and insulated by its own enclosure. These regulations," Tacitus continues, "it must be admitted, were of public utility and added much to the embellishment of the new city. But still the old plan of Rome was not without its advocates. It was thought more conducive to the health of its inhabitants. The narrowness of the streets and the elevation of the buildings served to exclude the rays of the sun; whereas the more open space, having neither shade nor shelter, left men exposed to the intense heat of the sun."

Vitruvius is the prototype of the omniscient architectural encyclopædists who have flourished since his rediscovery at the Renaissance; his ten books are a storehouse of facts illustrating Roman architecture. Fanciful theories and legends are mixed in with much practical and empirical wisdom as to building and sanitation, with a constant deference to Greek practice. The regulation of town-plans is dealt with in the first book. Building is divided into two parts, the first regulating the general plan and walls of a city and public buildings, and the second with private buildings. Chapters IV. and VI. deal with the choice of healthy situations and the distribution of buildings. Vitruvius is

anxious to protect streets from the fate of Mytilene in Lesbos, which was magnificently and elegantly designed and well built, but imprudently placed. Pulmonary disorders and gout are described as due to cold and cured with difficulty. A plan with eight main radiating streets separating the regions of the winds, to which they are not parallel and are thus dissipated, is described, and the octagonal Tower of Winds of Andronicus at Athens is cited. The lanes and streets being set, in Chapter VII. the choice of sites for the convenient use of the State is discussed, with reference to the moral influences on the old and young of Mars, Vulcan and Venus. The whole work has fascination to students of historic town-planning, and is evidence that from the Early Empire the founding of cities lay within the sphere of the practical political education of a Roman architect.

Rome grew under the Emperors to a city of several millions of inhabitants. Two or three thousand senatorial families lived in luxury and splendour, surrounded by an immense population lodged in miserable houses—almost the only property they possessed—supported by distributions of corn and largesses from the public treasury and entertained in the bath, circus and amphitheatre.

The magnificence of the forums was central and internal; the idea of architecture did not enlarge to the city as a whole, and while developing the public places took no account of streets or of the arrangement of buildings in avenues. Great roadways radiated outwards from the gates and internally struck across the city to the centre. The Via Triumphalis, which had its arch in the short wall between the Capitol and the river, was not treated with special dignity, and the buildings in the plain, or Campus Martius, the heart of modern Rome, were not composed together upon the thoroughfares, though many of them were large. No comprehensive town-plan dealt with the real needs of the city, only amenities, luxuries and public dignities were recognised. That which Republican Rome had not demanded was not proffered by the Emperors. Legislation, however, took cognisance of private as well as of public rights by restrictions or servitude attaching to land, in the earlier period, and from the third century B.C. to buildings within the city. Our modern legal doctrines and building practice, that recognise the joint ownership of party-walls, rights of light and prospect, limitations of height and rain-water carriage, are built upon Roman precedents. In the history of world capitals the regulations for such conditions repeat themselves.

(*To be continued.*)

HORSE-CHESTNUT CROP.

A scheme for the collection and utilisation of horse-chestnuts for munition purposes has now been approved, and the following circular is being sent to local education authorities and secondary schools:—

The Board of Education have been requested by the Minister of Munitions and the Food Controller to bring the following scheme to the notice of school authorities, governing bodies, and teachers, and to request their assistance in giving effect to it.

A considerable quantity of grain is at present being used in certain industrial processes which are essential to the prosecution of the war. In order to set this grain free for human consumption experiments have been made to discover a substitute which could be utilised for the industrial processes concerned, and a substitute suitable in every respect has been found in the horse-chestnut. The experiments prove that for every ton of horse-chestnuts which are harvested half a ton of grain can be saved for human consumption. The horse-chestnut, therefore, though itself totally unfit for food, can be utilised indirectly to increase the national food supply.

It is therefore urgently necessary that this year's crop of horse-chestnuts should be harvested. In present circumstances it is felt that school children could give most valuable assistance in collecting the chestnuts, and by so doing make a definite contribution to national efficiency. It is suggested, therefore, that the governing bodies, managers, and teachers of schools should organise the efforts of the children for the purpose. To effect this a small committee might be formed in connection with each school or convenient group of schools to undertake the organising work in connection with the scheme in the district concerned, and to answer inquiries.

It is understood that in many districts the scheme has already been taken up by private individuals, and it is obviously desirable that all persons undertaking work in connection with the scheme should co-operate with one another.

One of the duties of such a committee as is suggested above would be to see that the chestnuts gathered in their district are collected in a heap in some convenient place, preferably under cover; exposure to the weather will not, however, damage the nuts provided that the interior of the heap does not heat.

The nuts suffer no harm from lying on the ground where they fall. They may, therefore, be collected either from the trees or from the ground after being shed, as may be the more convenient. Before being deposited at the collecting station they should be

freed from the outer green husk, the shells of the nuts being left intact. If the husks are not removed heating of the heaps will certainly take place.

A limited number of sacks and baskets are available for the collection of the nuts, and where there is any difficulty in obtaining bags or baskets locally application should be made to the Director of Propellant Supplies, Ministry of Munitions, 32, Old Queen Street, London, S.W. (1)

When the collection is complete the committee should inform the Director of Propellant Supplies as above, stating the estimated quantity of the collection, and the Ministry of Munitions will arrange to remove the nuts and forward them to the factories in the course of the winter.

A valuable saving of grain will be thus effected if the scheme is generally taken up. The crop of nuts on the trees is said to be a good one, and it is believed that over 200,000 tons may be collected. Except as a food for deer and goats, the seeds have in the past been practically a waste crop.

MANGROVE SUPPLIES IN PORTO RICO.

Mangrove grows in sea water in marshes along the coast of Porto Rico, and in many places is abundant. There are several varieties called by different names, some of which are sources of tannic acid. Although the bark is sometimes used locally in tanning processes, as far as can be learned, writes the Correspondent at San Juan of the United States Department of Commerce, there has never been any attempt to make mangrove a source of commercial tannic acid.

One variety of mangrove, generally known in Porto Rico as "mangle zapatero" or "shoemaker's mangle," is considered to be the best variety for tanning and dyeing, and the extracted juice may also be used to neutralise the effect of salt water used in steam boilers. Frequently quantities of bark are thrown into a boiler to prevent "caking" on the pipes.

All of the varieties of mangrove grow slowly, and the "mangle zapatero" produces a knotty brittle wood. Two other varieties, known as "chifle de vaca" and "botoncillo," produce a tough, fairly straight wood, free from knots, and is believed to be suitable for tool handles or spokes for carriages and other vehicles.

Although this product has never been marketed, a price of £13 to £14 per ton, f.o.b. port of Mayaguez, has been quoted, packing either in sacks or otherwise, for the account of the purchaser. For the wood itself, cut in 2-ft. lengths and air-dried—a process which requires approximately two weeks—a price of 5*s.* per hundred pieces has been quoted. It is probable that these prices could be lowered for large orders for contract delivery, and after persons had an opportunity to become familiar with the preparation of either the wood or the bark. The supply should be abundant and constant.

DRAINING THE ZUIDER ZEE.

After being discussed at length in many columns of periodicals and hundreds of pages of books and pamphlets during three-quarters of a century, the proposition to drain the Zuider Zee finally reached the form of a Bill introduced into the Second Chamber of the Netherlands Parliament towards the end of last year.

The Bill provides for a dam across the upper part of the Zuider Zee, extending from the Province of North Holland, over the Amsteldiep (a narrow strait), to the island of Wieringen, and thence to the Friesland coast at the town of Piaam, in a north-easterly direction. Including the island, the total length of the dam would be about twenty-four miles; excluding the island, about nineteen miles of dam actually to be constructed. A lake of 882,000 acres in area would be formed, of which, it is understood, about 500,000 acres would be drained, leaving the remainder as a lake in the midst of the redeemed arable land.

As numerous fisher-folk depend upon the Zuider Zee for their livelihood, indemnity for such injury as they may suffer is contemplated. Possible damage to shipping and other interests is also taken into account.

It is estimated that the full execution of the project will require fifteen years, and will cost over £8,800,000, of which two-thirds would be for the dam and auxiliary works and one-third for the draining. In addition, writes the United States Consul at Amsterdam, there would be works and measures of a protective nature, following the draining, the cost whereof, as estimated, would swell the grand total to approximately £18,000,000. These works and measures will be the subject of another Bill to be introduced in the Parliament.

When work on the project will begin is not yet known, but it will be decided as the Bill progresses through the Parliament. Long discussion and consideration is expected. Many interests which will be affected must be taken into account. Among them are the canals of Amsterdam, which are flushed and freshened by water pumped from the Zuider Zee, and provision therefor must be arranged.

It is calculated that the dam will be completed in the ninth year of work on the project. In the fourth year work will begin on dykes for the area to be reclaimed.

THE ATTAR OF ROSE INDUSTRY IN BULGARIA.

The most ancient and most attractive Bulgarian industry was the cultivation of the rose, from which was distilled the well-known essence "Attar of Rose." Bulgaria's extensive rose fields are on the southern slopes of the Balkan Mountains, the rose district being eighty miles in length, thirty miles in width, with an average height above sea-level of 1,300 ft.

Several conditions are essential for the cultivation of the rose and the production of the attar. The soil must be easily permeable to water; the bushes must be protected from the cold north winds of the winter; there must be no excess of unseasonable rain, and no early and excessive droughts. These conditions all exist in the "Rose Valley," where the rose thrives as in no other spot on earth. After Bulgaria attained its independence from Turkey in 1878, the Ottoman Government attempted to establish the rose industry in Asia Minor, many acres of gardens being planted around Broussa, where roses grew in abundance; but upon distillation these roses produced practically none of the attar.

In Bulgaria but two varieties of roses are cultivated—the red, "Rosa Damascena," and the white, "Rosa Alba," which are combined in the process of distillation; but the red rose, which resembles the French "Rose du Roi," is richer in perfume and essence than the white. In the Rose Valley, where there are some 20,000 acres of gardens, the atmosphere of the entire district is charged with perfume when the roses are in bloom.

The planting of a rose garden is much like that of a vineyard. The soil is prepared by careful tilling and fertilising, ditches being dug in rows a foot and a half in depth and width, and a yard and a half apart. The shoots are planted in the bottoms of these ditches in a mixture of soft earth and manure, and within a year the bushes are about a foot high.

The first crop of consequence comes with the third year. The bushes attain their full growth, about 6 ft., in the fifth year, and continue to yield abundantly for twenty years. There is but one crop a year, the harvest beginning about the third week in May and lasting eighteen to thirty days, the duration depending on weather conditions. In hot summers the harvesting proceeds rapidly, the plants completely flowering in fourteen to twenty days.

The roses, gathered by women and girls, are carried to the near-by distillery, spread out in cool, cemented chambers, and distilled the same day. The gathering continues from daybreak until ten or eleven o'clock, or, if the day is cloudy, for an hour or two longer; roses gathered in a hot sun have a comparatively feeble odour and yield but little essence. In times of rapid harvests the flowers are often so plentiful that they overtax the capacity of the stills and have to be thrown away.

The alembic, or still, is usually of the simplest construction: a convex, tinned copper boiler, narrowed at the top to a neck on which is affixed a spherical head. It is about 3½ ft. high, the diameter at the widest part being about 2¼ ft. From the head a straight tube inclines to a warm condenser placed in a tub of running water. The average capacity of the still is 20 gallons, 20 lb. of roses and 15 gallons of water being used. This first distillation, which is completed in about forty-five minutes, yields 30 to 35 lb. of rose water, which is redistilled—100 to 120 lb. producing some 30 lb. of the second distillate—to get the concentrated extract. The extract is strong in odour and has a turbid appearance from the presence of minute yellow-white globules—the attar—which, being lighter than the liquid, gradually rise to the surface and are carefully skimmed off.

It appears from a report by the United States Consul lately at Sofia, that about 20,000 acres are devoted to rose culture in Bulgaria, the annual harvest yielding 35,000,000 to 45,000,000 lb., or about 8,000,000,000 roses. A one-acre garden under favourable conditions produces 2,000 to 2,500 lb. of roses, from which 10 to 15 oz. of attar of rose may be distilled. Generally, 180 to 200 lb. of roses will produce 1 oz. of the attar; there are about 200 roses to the lb. The total production of the attar varies with the seasons, but it averages 175,000 oz.

The largest rose crops on record were those of 1900, 1903, and 1906, which resulted in 180,000 oz., 210,000 oz., and 225,000 oz. of attar respectively. The 1916 production was small in comparison, not more than 110,000 oz. being distilled.

Nearly all the attar of rose produced in Bulgaria is exported, the largest markets, prior to the war, being Paris, London, and New York. The export in 1900 amounted to 180,000 oz., in 1905 to 210,000 oz., and in 1910 to 216,000 oz. The average price, prior to the war, was £2 10*s*. per oz.

At one time, during the Turkish *régime*, the rose leaves were sprinkled with geranium oil, which produced a heavy yield of attar upon distillation; but this practice has long since been discontinued, as the attar obtained partook more of the perfume of the geranium than of the rose.

The rose crop of Bulgaria is subject to damage from hailstorms, excessive cold, and early and deceptive spring frost during the budding season, and hot, dry weather in the harvest time. In the last two lies the greatest danger.

ARTS AND CRAFTS.

"The Exhibition of Designs submitted in Competition for the Owen Jones Prizes.—Now that there is no longer a National Competition a good deal more interest than usual attaches to the competition for the Owen Jones prizes, under the auspices of the Royal Society of Arts, as it gives at least some chance of judging of what is being done in various parts of the country. It was, therefore, peculiarly fitting that an opportunity should be afforded for those interested in applied art to see what had been sent in and that the little exhibition of the designs should be held at the Victoria

and Albert Museum. It is to be hoped that as time goes on an increasing number of London art masters and others will have profited by the opportunity of seeing, at any rate in some degree, what is being done in other important centres. Competitions may, of course, be overdone (it was sometimes said that students worked too long and too directly in preparation for National Competition); but within certain limits they undoubtedly have their uses, for they not only stimulate the students to put forward all their powers to one definite end, but also help the masters to see how their own pupils compare with others.

The Partial Closing of the Victoria and Albert Museum.—Exhibitions such as this make one regret all the more that so much of the Victoria and Albert Museum is to be taken over for offices by the Board of Education. The Museum has, since the war broke out, served a number of useful purposes, all more or less connected with its own particular business. To house the Board of Education hardly seems to fall within its province. Whatever may have been the wisdom of holding such giant exhibitions as the British Industries Fair in the building, that was but a temporary expedient bound to come to an end within a short specified period. The present arrangement will be of longer duration, and will have much more far-reaching results. Everyone knows the difficulty of obtaining office accommodation on a large scale just now, and some of us remember the days when the old Science and Art Department had its quarters in the old buildings of the "South Kensington Museum"; but now that, after long and weary waiting, the wonderful treasures of the Victoria and Albert Museum are at last adequately housed and arranged, it seems very mistaken policy to render a considerable portion of them inaccessible. It certainly cannot be regarded as a good thing for the art education of the country, and for the boys and girls now training in art, that the contents of our great museums are becoming less and less visible. The closing of the British Museum nearly eighteen months ago was a blow; the partial closing of the Victoria and Albert Museum means that the young people who are to be ready to make British artistic manufactures come to their own after the war will be deprived, in some measure at least, of one of the most potent aids to education, whilst the overseas soldiers have yet another disappointment to face in London. It seems lamentable that a country so rich as our own, and so plentifully supplied with art treasures, should not have made the effort, successfully attempted by her poorer and less richly endowed neighbours, to keep these great national storehouses open to the public. The closing and partial closing of them has been a real loss to the public at large, especially to the many provincial and colonial soldiers stationed in or passing through the metropolis—but it is of far greater moment to students. Is it too much to hope that more objects will be put into circulation? There seems no reason why schools not too distant by rail from London, nor too much within the range of air raids, should not be allowed to profit by London's loss. Such an arrangement should be a real help to the provincial schools, and would go some way towards neutralising the bad effect of the partial closing of the Victoria and Albert Museum.

Embroidery.—Though the embroidery trade has in some ways been very much affected by the war, though people have for the most part no leisure for fancy work and no money to spend on buying it, there is much more embroidery of various kinds being done than one would perhaps have expected. To begin with, trade embroideresses employed by the dressmaking and other trades have been unusually busy; but besides this not only are some of the philanthropic or semi-philanthropic societies doing a fair amount of work, but wounded soldiers are being encouraged in fairly considerable numbers to take it up, at any rate as a hobby. Meanwhile there is quite a good deal of Church work being ordered. Vestments, of course, have to be kept in repair and renewed, and one would hardly have expected any very marked diminution of orders of this kind, though one would have anticipated that they would have been, for the most part, for a simple type of work. What is rather astonishing is the demand for banners. It is understandable that certain kinds of banners should be regarded as suitable memorials to those who have fallen in the war, but there seems little reason that banners not intended to serve this purpose should be put in hand just now. One would have expected Church banners to be ordered freely after the conclusion of peace, but not in the middle of war. Another and very different branch of work, which still goes on in some districts at least with unabated vigour, is quilt-making. In parts of Wales, for instance, where a certain number of quilts are included naturally in every girl's trousseau, the quilt-maker is still happily and industriously plying her trade—either following out traditional patterns or adapting them, or evolving fresh ones as she goes on with her work. To see her sitting at her frame, just indicating the main features of her design with chalk line, setting out her straight lines with a piece of chalked thread, which leaves a white line on the material and suffices to guide her and is afterwards easily rubbed off, and keeping her whole scheme in her head while only a comparatively small portion of the pattern is visible, carries one back to the days when many peasant industries were quietly carried on in this way from generation to generation, and makes war seem an impossibly far-away contingency. Had more crafts been carried on in this natural and homely fashion there would have been little need for societies to revive home arts and industries, and, perhaps, even "arts and crafts" would have been regarded as natural adjuncts to everyday life, and not as the name for what has become a semi-artistic, semi-social movement.

OBITUARY.

EDWIN HODGE BANKS.—Mr. Edwin Hodge Banks, of Highmoor, Wigton, died on the 21st inst. at Brighton. He was called to the Bar at the Inner Temple, but never practised. He was, however, a prominent figure in public life in Cumberland, having been chairman of the Wigton Urban Council for a generation, and a member of the Cumberland County Council. He was also a keen agriculturist, and did much to promote the breeding of blood stock in the country.

He had been a member of the Royal Society of Arts since 1878.

GENERAL NOTES.

THE STRENGTH OF FERRO-CONCRETE.—The difficulty of destroying reinforced concrete buildings is shown in an article on concrete in war which appeared in the *Times Engineering Supplement*. While steel cupolas have been blown to pieces by high-explosive shells, similar structures in reinforced concrete have withstood bombardment with comparatively little injury. Many of the reinforced concrete buildings scattered over Northern France have shown remarkable capacity for withstanding artillery fire. One case is quoted of an elevated reservoir about 80 ft. long, 40 ft. wide, and 12 ft. deep, supported on a framework of thin columns more than 40 ft. high. The flat roof at a height of 55 ft. was used by the Germans as an observation post. The reservoir, built in 1911 of Hennebique ferro-concrete, was destroyed so far as possible when the Germans evacuated the town last March, after it had successfully withstood our bombardment, which destroyed all surrounding buildings. The columns were broken by explosives, allowing the reservoir proper to fall to the ground, where it remained intact save for a few cracks and holes cut in the corners, where explosives had been inserted with the object of damaging the walls.

THE ALCOHOL INDUSTRY IN THE TROPICS.—Mr. H. C. Brill, of the Bureau of Science, Manila, reviews in *Tropical Life* the outlook for the alcohol industry in the Philippines and the tropics generally. Three of the cheapest sources of alcohol occur in tropical countries, viz., sugar-cane molasses, "tuba" from the nipa palm, and possibly from the coconut palm, and starch from such plants as cassava and arrowroot. In 1914 the Philippines produced about 12,000,000 proof litres of alcohol, of which more than 95 per cent. was made from the sap of the nipa and coco palms. The molasses fermentation industry has suffered much from faulty methods, but considerable improvement is being effected through the Bureau of Science. The nipa palm provides a cheap source of alcohol, each fruit stalk yielding normally 30 to 50 litres of sap during a season, equivalent to an output per hectare of fully 30,000 litres of juice with an average sugar content of 15 per cent. The utilisation of starch plants still awaits development. It is estimated that an average acre of cassava would yield more than three times as much starch as an average acre of maize, whilst, in addition, the cassava contains 4 to 6 per cent. of fermentable sugars. Arrowroot yields 18 to 22 per cent. of starch. It is predicted that when these sources are developed the tropical countries will secure a practical monopoly of the alcohol industry.

COPPER IN BRITISH COLUMBIA.—British Columbia is becoming one of the world's leading copper producers. In 1915 the increase in amount was 11,908,706 lb. and in value $3,714,181 over the previous year. For 1916 there is a still further increase over 1915 of about 17,000,000 lb. in quantity and about $8,500,000 in value. The estimate for 1917 is 73,000,000 lb., and, allowing for the usual charges for mining and transportation to foreign refineries, the value in British Columbia may be placed at about $18,250,000. The copper output will steadily increase, says the *Syren*, as there are new metallurgical plants and new mines with reserves capable of increasing the production of the past year by 50 per cent. The time is not far distant when the copper produced in British Columbia will be practically all smelted and refined in the province, and the Dominion and Provincial Governments are considering the best means of bringing this about.

WATER-POWER IN THE FRENCH ALPS.—Professor R. Blanchard, in a paper in the *Annales de Géographie*, takes stock of the present position in the development of water-power in the French Alps. Between 1903 and 1916 the total horse-power supplied by the waters of Haute-Savoie, Savoie, and Isère rose from 145,000 to 528,000. In Haute-Savoie the means of communication are difficult, and the power generated is in great part transported to workshops outside the mountains. In Savoie there are excellent means of communication, but local differences in the slope and form of the valleys result in irregular distribution of the workshops, which tend to congregate in certain localities such as the courses of the Arve and Bonnant near their junction. The interior valleys show the greatest advance of all—an increase of 74 per cent. between 1910 and 1916—and use more than half the total horse-power generated in the region. The Southern Alps suffer from deficiency and irregularity of water-supply, and the absence of glaciation renders the forms of the valleys less favourable; but some progress has been made along the middle course of the Durance and in the Maritime Alps.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

CIVIC ARCHITECTURE AND TOWN-PLANNING.*

By PROFESSOR BERESFORD PITE, F.R.I.B.A.

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Lecture II.—Delivered February 5th, 1917.

(Continued from page 682.)

ROMAN CITIES.

The political genius of Rome secured coherence to its Empire and illustrated its Alexandrine succession by the foundation of cities. They were knots systematically woven in the network on which the serviceableness and endurance of the whole depended. The number and importance of the cities planted and maintained in prosperity during the first five centuries of the Christian Era by Rome was immense. Gibbon computes, in an estimate which is accepted, the population of the Empire when the census of Claudius showed nearly seven millions of citizens, at one hundred and seventy millions of persons, and collects "a few scattered instances" to illustrate the number of flourishing cities. Ancient Italy is said to have contained eleven hundred and ninety-seven; Gaul boasted of twelve hundred; Pliny gives a list of three hundred and sixty in Spain; three hundred had been under the authority of Carthage before its recovery under the Romans. Asia proper contained five hundred populous cities, many of great size and splendour, and the woods of Britain were gradually cleared for habitation, York, of the nine colonies, being the seat of government, London of commerce, and Bath celebrated for its medicinal waters. The legions kept the frontiers, but civilisation and social prosperity within were promoted in lands of new or old settlement by the policy of city foundation. The great roads to Rome, bridges, aqueducts and monumental buildings, in themselves are important concrete vestiges of widespread imperial power and engineering genius; but these are rather ancillary, in a completer perspective, to the planting of new cities, each a practical witness to the interest of the superior government in social organisation. There is justification for claiming authoritative town-planning as an instrument of beneficent government and as a corollary of the peace imposed upon the world by Rome.

A formal, official type of plan and of architectural treatment was essential and artistically justifiable; the world was then too young to quarrel with or criticise its only master in the school of civilisation. The city was laid out as free as possible from the accidents of picturesque or sacred sites, which were left external to the walls. The fixed type was strictly rectangular, similar to the fundamental plan of a military camp. The walled area was divided by two relatively wide streets intersecting at right angles at the central forum, and the resulting areas again subdivided by narrower lanes into square insulæ of no great size. Temples, baths, theatres and other public buildings did not disturb the general idea, and were either placed in the forum or near by. The architectural grouping of buildings or the planning of streets in relation to special features or buildings was disregarded. The Roman town-plan was in itself rigid and uninteresting, but practical, orderly and governmental.

The decorative architectural elements were stereotyped, uniformly respectable and indicative of the culture of the imperial state of the applied Grecian school as demonstrated by Vitruvius. From the north-western to the south-eastern confines of the known world, from Britain to the Parthian frontiers, the style is invariable, wrought out with degrees of skill,

* The course consisted of four lectures, delivered on January 29th, February 5th, 12th, and 19th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into six parts.

richness and scale; the ornamental features are multiplied, but seldom varied. The sincerity of Roman self-confidence in design atones and accounts for the lack of imagination—where freedom was not permissible there was no scope for variety. We are not inclined, moreover, to quarrel with the interest and simplicity of the Roman remains in England, and can discern their value under the very different climatic effects of the East. A style was practically evolved of universal application that, strangely enough, appears to be re-vindicating itself to-day in any review of the world architecture of modern civilisation. The splendid deserted ruins which by no figure of speech abound in Asia Minor, Syria and North Africa witness to an ideal of civic architecture which have a message to the ideals of town-planning in any age not oblivious of the dignity of social order.

In the sunny climate of the East the scheme of the stoa colonnade was applied to the main crossing streets; the footways were covered over and became continuous porticoes to the bazaars, the flat roofs providing terraces for sleeping out. These colonnades grow magnificent in scale, and with the triumphal arches at their entrances and intersections create an effect of civic architecture that is unique and satisfying. This peculiarly Roman system of the imposition of an architectural face by colonnades had the interesting economic result of relieving the ordinary street buildings of any necessity of employing an architectural dress; the arrangement of elevations into a street is an evidence of later and more particular civic development The official portico masked all constructional irregularities, so that mud walls and straw roofs mingled with the compounds of palaces behind the screen, and did not promote activity in sanitary or artistic reformation. The result was a combination of organised fictitious architectural splendour with Oriental domestic squalor that can be realised to-day, as then, in many historic cities. The solid masonry of the Roman columns and entablatures in many instances remains, fallen or erect, while the structures of the town have melted away in dust and mud. In Europe cities of Roman foundation have become absorbed into the life of modern communities though retaining some few indications of the lines of their primary streets and limits.

Jerusalem and Damascus are illustrations of ancient cities improved by the creation of great thoroughfares under Roman administration, new streets being formed in direct lines and emphasised by colonnades. Herod the Great town-planned the former with a street of columns from his palace to the Temple enclosure; and at Sebaste, which he rebuilt on the site of Samaria, are the solitary remains of a street of columns extending a mile outside the present town. The well-watered Damascus, the most ancient city of the East, was improved by the work of a talented native architect, Apollodorus, who was employed by Trajan at Rome. Here a double colonnaded street was built having two stories of shops leading to the peribolus of the house of Rimmon, that had become the Temple of Zeus, the propyleum of which and "the street that is called straight," the Via Recta, with its entrance gate remain, and many fragments indicating the magnificence of the scheme of the city plan.

Antioch, next to Alexandria, the greatest city of the Hellenistic world, was celebrated for a double colonnaded street two miles in length, leading to the beautiful park of Daphne. The repute of this city, founded by Seleucus, greatly influenced subsequent Roman building in Syria.

The system culminated in the time of Hadrian at Palmyra, situated on the Roman road through the desert, for Eastern trade the alternative to the Red Sea route. This wealthy city was a fiscal rather than an industrial centre, and appropriately the successful conduct of a caravan was rewarded by the erection of a statue to the merchant upon the attic of the portico, and by an inscription on the tablet which every column bore upon its face. These colonnaded streets were the wonder and pride of the East, with their painted ceilings and brazen or Corinthian capitals. The crossing of the central avenue is marked by four great pedestals having groups of columns against which the porticoes abutted, the cross streets are marked by arches, and an ingeniously planned triangular archway masks an angle in the main axis that probably indicates the line of an older street. In all about 750 columns were employed; they were 55 ft. high, and thus of a scale which reduces the Regent Street Quadrant of Nash to a trifle, and more nearly corresponds with the peristyle of the British Museum.

The Roman art of impressive planning and its formal architectural apparatus evolved the forums at Rome and the columned streets of the provinces. In each a sense of magnificence develops itself to its utmost limits; but the combination of both systems of design in the composition of streets, open places and buildings yet remained unattempted, though the method of architectural treatment is still the

working capital of the executors of the Roman estate. Impressive planning reached its acme in the spacious atmosphere of the Lebanon in the Temple of the Sun at Heliopolis or Baalbec, built by the two Antonines, Severus, and Caracalla in the broad valley of the Anti-Libanus ranges, dedicated from the highest antiquity to the worship of Baal. This is a great plan of spacious enclosures concentrating with architectural power upon the temple façade. The propyleum portico is 180 ft. in length between the wings raised upon a great series of steps. Access is obtained to a remarkable outer court of hexagonal shape colonnaded and surrounded by halls. Beyond, on the central axis, is the great court, 300 ft. square, in the centre of which is the rock altar flanked by cisterns. On three sides are colonnades covering halls and apsidal exedræ; and on the fourth is the lofty basement of the huge temple. Babylon and Thebes both contributed to the idea as well as the progressive magnitude of the forums of Nerva and Trajan at Rome, and of the enormous Temple of Jupiter Olympius at Athens, recently completed by Hadrian.

The palace city of Diocletian, built for his retirement at Spalato upon the eastern shore of the Adriatic, is small, covering only ten acres; it fronts on the sea, and has at once the characteristics of a Roman town-plan and of a palace into which civic life did not actually enter. It is a glorified camp, compact, secure and dignified. The city is square, and is divided into quarters by crossing double colonnaded streets; the palace occupies the whole of the southern side, and has a great gallery extending along the whole of the southern or sea front. Two of the quarters are occupied with temples, and the main walls of the city and of the quarters are lined with porticoes and chambers. Roman architectural art, like the Cæsars, had by this time run its course, and in spite of its unity and extent the plan lacks the interest and beauty of the forums and palaces of the capital.

Constantinople.

The universal Empire of the Cæsars occupies the historic interval between the ancient and the modern world. The organised architecture of Imperial Rome was without freedom, centralised in method, politically selfish, and exploited both the wealth of the East and the art of Greece. Moral or religious purpose is not evident in it, and, without sympathy either for the buildings of a beneficial government or for religion, forums, palaces, baths, and amphitheatres dominated civil architecture; even the boon of aqueducts was in no little measure consequent on the luxurious requirements of the baths and palaces. Sweet domestic art and the solemn grandeur of the tomb are alike absent.

The growth of Christianity, first as a popular force and afterwards as a State policy, effected the revolution that involved a new Rome, and the scene changed with the ideal. Architectural splendour was no longer to be an attribute and witness to a Cæsarian divinity; the new religion had not only put an end to schemes like Baalbec, but undermined the luxuriant pomp of the palaces and the selfishness of senatorial and civic life, and was claiming for itself a new service from art. Throughout the ensuing Dark and Middle Ages we shall not again meet with ample forums grouped with temples and basilicas, or with baths, hippodromes and palaces incessantly expanding on an Assyrian scale. The barbarians, ere long, were victorious, and when, after their subjugation, civilisation again resumed its westward flow, the architecture of Europe reflected mainly the non-civic activities of the Church and the universal belligerency of the Middle Ages, until the semblance of the arts of a bygone world reappear in the shadowy fancies of the Renaissance.

The architectural era was but recently great; the baths of Caracalla at Rome were quite modern, and the vast arches of the Basilica of Maxentius and Constantine attest the fullest development of the art of building; but the age of artistic ideals, whether of the ancient or Hellenic East or of experiment in philosophical planning, was rapidly passing away, and at the emergency architecture was barren and without inspiration.

The old historic capital had gradually become a nuisance to the Emperors, who seldom visited and more rarely resided in it, their presence being required with the armies, and its social conditions discredited their government. The Empire had become increasingly unmanageable from a capital that looked westward; the barbarians of the north-east developed a constant menace that needed checking nearer its source; Rome was threatened with the breaking-off of the Eastern provinces that supplied her corn and wealth; the whole system was loosening, and Diocletian had already contemplated the distribution of the government into four capitals.

Constantine, who had remodelled the army, reformed the executive and adopted the new religion, recognised that the political and social disorganisation of the Mediterranean world

demanded the venture of originating a new Rome for the effective unification of the Empire. Ancient Eastern monarchies, followed by Alexander who had no historic ties, had from time to time shifted their capital centres, generally as a result of expansion by conquest. The Roman Empire, however, had now become fixed as to its limits, and felt itself incapable of expansion; the need of breaking with an effete social order and of establishing shorter routes of communication with the frontiers, as well as with its sources of supply, determined and justified the great resolution—perhaps the most momentous in the history of town-planning—to refound the capital of the world.

The traditional Roman architectural prescription in civic planning, imposed by the mistress upon her daughters, would properly have demanded a clear site free from limitations or conflicting features; but the expenditure of time and money involved was likely to deprive such an enterprise of the popularity necessary to its success. No dream of a city, ideally and comprehensively planned on any formal design, appears to have been demanded or attempted, and this preliminary architectural shortcoming is indicative not so much of want of prevision as of the decay of Roman courage and power. Constantine was neither a second Alexander nor Hadrian; his imagination was controlled by a statesmanlike prudence; when the decision had been taken its most rapid execution was essential; therefore the taking over and extension of a modernised city, in working order, offered practical and economical advantages that his common-sense could not refuse. The great opportunity was sacrificed to utilitarianism, and the new Rome thus becomes typical of our own motives in town-planning and in many respects the primary city of the modern world.

Naval and military strategists will not dispute Constantine's genius in the selection of Byzantium for the new Rome. Other promising sites were considered, strangely illustrating the constant values in town location throughout ancient and modern history: among these were Nish in Servia, the birthplace of the Emperor, and Sofia in Bulgaria; in Asia, Nicomedia across the Bosphorus, one of Diocletian's proposed centres, and ancient Troy at the mouth of the Hellespont, which offered practical as well as poetical advantage. But in the dim past of a thousand years, about the time of the foundation of Rome, the Delphic oracle had cast a significant reflection on the founders of Chalcedon, near Scutari, on the eastern shore of the Bosphorus, by directing the eyes of an inquiring group of colonists from Megara to the site opposite to "the city of the blind." Byzas took the hint as to the superiority of the European side and founded Byzantium. The ancient settlement had become a free and confederate Roman city, but in later times was reduced to a colony; recently Severus had besieged and partially destroyed it, but afterwards rebuilt it, as a necessary outpost against the northern barbarians, on accepted Roman lines; and here Licinius, after his defeat at Adrianople, had again been vanquished by Constantine in 323 A.D.

The site of Byzantium is a triangular sea-girt peninsula; a ridge rising to a height of 250 ft. broken with hills that can be reckoned as seven, extends for a distance of nearly four miles from the Acropolis at the apex along the northern shore to the open country on the landward base, the only position where a defensive wall was required. The deep tideless harbour, shaped like a horn and called golden on account of its wealth of fish, forms the northern side, its crescent shape and a star in memory of a portent that delivered the city from Philip of Macedon compose the device of the city. The Sea of Marmora on the south-west takes its name from the quarries of Proconnessian marble awaiting the builders; the climate is temperate and the situation and prospect of unusual beauty; the approaches from the Black Sea or from the Ægean through the narrow and difficult gates of the Bosphorus and Dardanelles ensured military security, and the position geographically dominates the contact of two continents. All these qualities unite in bestowing upon the city, planted upon this wedge of Europe, a power and vitality that it is hard to overestimate. Here upon a scientifically chosen site was accomplished the immense undertaking of re-centring a world-empire already historic and ancient.

But the political and economic conditions which combined against the production of a great architectural plan for the new city, and led to the adaptation of Byzantium, also seem to have involved the destruction of the authentic Roman traditions of town-planning by this capital example of consequences ensuing from the topography of the site.

The apex of the triangle, the Seraglio Point, was occupied by the ancient Acropolis, and its original circuit was the city wall. Successive enlargements necessarily took place on the landward side. The rebuilding by Severus a century and a quarter before Constantine included a

wall of great strength from the Golden Horn to the Sea of Marmora, having the Sublime Porte, or gate of Byzantium, in its centre, from which proceeded the main street, central both to the city and peninsula. The new Rome more than doubled the area of the earlier city, and streets radiated to three gates in the outer wall extending from sea to sea. The royal and official quarters took possession of the apex and of the ancient city, and the new area was laid out with the inevitable characteristics of a suburb. Within a century the population had so increased, partly owing to the invasion of Italy by the Goths, that a large extension of a similar character had to be undertaken by the erection of the great walls of Theodosius II. at a distance of from one to one and a half miles beyond those of Constantine, and, like them, extending from the Horn to the Sea: these are still intact, in spite of siege and earthquake. From the three gates of Constantine's wall roads diverge to the seven gates of those of Theodosius, the three main roads retaining their direction on each side and at the centre of the triangular plan. The suburban character became stereotyped as the new quarters extended outwards, and the plan became a mere attenuation. Circulation around the heart, where improvement was impossible, distorted the streams of traffic, and the sense of dignified arrangement faded away as the distance from the apex increased.

The benign influence of the protection afforded by walls throughout the troublous era of wars with barbarians and Saracens that was now dawning is characteristic of the first millennium of State Christianity. A defensible site fortified by military architecture became the primary condition of city building; growth ensuing from security engendered congestion, and thus the idea of a comprehensive design for the internal plan disappeared. The Imperial civic ideal was crushed by the military advantages of the peninsula of Byzantium, and the example of the abandonment of an architectural plan for the new capital was probably the principal cause of the decline and fall of town-planning in the Roman world.

Constantinople thus marks an advance from ancient to mediæval and modern habits of thought. The acceptance of inconvenient limitations, originally due to the essential requirement of defensibility, has become a facile virtue with many besides civic authorities. Such compliance had been unnecessary to the Cæsars in the days of their strength, when Augustus and Trajan carved their forums out of the rocks of the Septimontium, superior to the considerations that under Constantine outweighed an architectural ideal. But we may well doubt whether the *pis aller* of adopting Byzantium justified the abandonment of the settled Roman doctrine and practice of town-planning, and believe that a more courageous tyrant could have re-centred a nobler scheme upon the unique site of the Golden Horn.

No heroic alteration of levels was attempted in the extension of the streets of Severus and Caracalla. The central colonnaded way was continued as a spine to the triangle, others were laid out fanwise from the ancient gate in the centre, the Sublime Porte, and the Triumphal Way laid near the shore of the Sea of Marmora. Constantine placed his new forum at the ancient gate on the crest of the ridge, with triumphal arches at each end, and in it erected the golden milestone—a lofty porphyry column surmounted by a statue of Apollo from Phrygia, reputed to be by Phidias. His toleration preserved and erected pagan shrines besides founding Christian churches, the Basilica of the Sacred Wisdom replaced the Temple of Minerva on the Acropolis, and the new influence, while embodying the alliance between the State and the old and new religions, tended to diminish that of the amphitheatres and stadium. The entrance to his palace, we are told, was decorated with a large cross. Superficially the enlarged city was enriched after the Roman manner with porticoes, arches, columns and statues, and historical antiques, such as the tripod pedestal of the Pythian oracle, were placed on prominent sites. Adjoining the Hippodrome, which stood on the landward side of the Acropolis, was the imperial palace, with extensive gardens extending to Seraglio Point, and commanding a marvellous prospect of the Asiatic shore. Here, in Gibbon's picturesque phrase, "the seat of Turkish jealousy and despotism is erected on the foundations of a Grecian republic."

The work was commenced in 328 A.D., and hurried forward so that the transference took place within two years. Masons were brought from Italy, and 40,000 Gothic troops were employed, possibly on the military buildings. There appears to have been a lack of architects, as the inducement of freedom from taxation was offered to master-artificers to train their sons as builders. The capital had been reduced to dependence upon the Government, and permanently deteriorated in character, by the mischievous dole that was originated five centuries

earlier by the Gracchi as part of their scheme of reform, but a drastic and practical use was now made of this system to provide inhabitants by diverting the daily ration of 80,000 loaves from old to new Rome. Mansions were erected for senators and estates granted in Pontus and Asia on the terms of maintaining a residence in the capital. A new regard for the interests of the civil population had become necessary, and we note this dawning recognition of what is now the fundamental sanction of town-planning.

The privileges and commercial advantages of the new capital continued to attract inhabitants until the overcrowding involved small sites and narrow lanes. The extension of the boundaries that followed eighty years after the foundation had fixed the main limits for good, but the important suburb of Sycæ, or the figs, now called Pera or Galata, across the Golden Horn, sprang up, connected by a wooden bridge; later, an extra-mural suburb developed at Blachernæ, at the northern end of the newer wall, where a magnificent royal palace was situated. The absence of scheme in these enlargements is as significant as the lack of design in the planning of the harbours adjacent to the coast walls both on the north and south, and reminds us that not only had Roman organisation declined, but that imaginative Greek perception of the natural possibilities of sites had ceased to glow even amidst the wonderful beauties of Constantinople.

The equality of the new capital of the East with her ancient and historic mother of the West was soon achieved, and, in spite of much political and religious mutation, has been maintained; but their interest to the student of town-planning ceases for well-nigh a thousand years; then revival came to Rome with the capture of Constantinople by the Turks. It tarries for the latter until possessed by a race capable of appreciating and developing both a civil life and a civic architecture.

The Dark and Middle Ages.

Architecture faded away with the decline of Rome. The military civilisation and the egregious extravagance of the Cæsars, which had ministered to its growth, withered under the growing effectiveness of the Gothic invasions and the penetration of Christianity. During the latter half of the first millennium of our era the coherence of the citizens was sought, and is expressed only by the external fortification of the towns. The civil forum ceased, the direct geometrical lines of the Roman thoroughfares became obliterated within the pressure of the walls, and are difficult to trace even in cities that have survived uninterruptedly. The Goths, Franks and Vandals were nomadic races, and, like their more intellectual and destructive rivals the Saracens, were constitutionally incapable of effective rebuilding. It is, therefore, not to be wondered at that town-planning disappeared with other Roman ideals, and so completely that a systematic aversion to its Pagan origin may be almost inferred amongst Christians and Moslems. In a small degree, within its limited area and early history, Britain illustrates the operation of these conditions, where so little remains to exhibit the Roman civilisation that had been imposed for three centuries on a generous scale.

Warfare and religion absorbed the arts of building to the exclusion of town-planning during the long eras of the Dark and Middle Ages. The social system of Europe became fragmentary; in the East a shrinking imperialism maintained itself; in the West the Holy Roman Empire was in incessant flux and, apart from the personality of the Emperors, a political figment.

The architectural art of Christendom for a thousand years after the rebuilding of Santa Sophia in the sixth century, so far as it was non-military, is ecclesiastical, votive and gracious, and its religious character alone expresses nobility in the Latin world. Domestic art, where secure, was tending to simplicity, but in its higher sphere affected gorgeous rather than solid or permanent pomp. The intelligent regulation of town building based on any original or derived social philosophy was non-existent; the strong walls and deep moats dwarfed and troubled internal improvements, and out of a long and deeply important period of social history and of ecclesiastical art very little material for the student of civic architecture issues.

The charm of a typically mediæval city is, however, indisputable; an entirely Roman world would to us be unendurably dull, its regularity of type and detail petrifies imagination, and we are not entirely satisfied with an ordered dignity that has no place for the picturesque freedom of the Gothic towns. Though belonging to our subject, we must not be led aside into a discussion of the elements of beauty in nature and art, or of the values that alternately charm us in a fortified cathedral city or a classically planned capital quarter; it must be sufficient that historic interest and picturesque ruin are both accents and accidents unattainable by the modern architect, and do not arise from intelligent forethought in plan design. An

imitative cult of crookedness, of narrow winding streets, of irregular and unexpected places and sites, will not ultimately justify itself as intelligent civic design. Convenience of traffic, dignity of grouping in public buildings, and sanitary spaciousness for private dwellings, are the accidents of mediæval as they were the principles of Roman town-planning; the exceptions that exist do not originate in the recognition of any principle of design, and are not supported by any general system.

It is sad that growth and improvement seem inevitably to demand the sacrifice of the mediæval margins to street widening; in the majority of instances civic development involves the subduing of all obstacles presented to an increasing volume of traffic by the frontages of ancient buildings, and towns that do not yield to the requirement of convenience are doomed to the slumber and decay beloved of artists and dreaming poets. The progress of civilisation is almost expressed in assisted locomotion and improved communications; the pack-horse is succeeded by the wheeled vehicle, the tramway; railway and automobile follow, and are evident and potent factors in town-planning to-day in the planning of a civic life that is movement.

Professor Baldwin Brown, writing on Saxon England, says that towns form themselves, though afterwards taken up and shaped for military or administrative purposes; he cites Thomas Kerslake (*Archæological Journal*, XXXIV. p. 200) to this effect. The meeting of *two* people or sets of people may be at any point, but where *three* have to meet the point where two paths fall into one is the natural place of forgathering. Where there are two buyers to one seller or two sellers to one buyer, there we have the principle of the market. "These triangular spots are the first cradle of that giant whom we now see with his seven-leagued boots, ships and railways, striding across oceans and continents." Then the placing of the market cross, the refreshment booth, the smithy and store for the salt and iron which village communities could not produce for themselves. Then the church. The vast triangular market at Nottingham, the bull-ring at Birmingham commanded by St. Martin's Church; Kidderminster, Shrewsbury and other illustrations follow. These principles are still in operation both in the progressive England of the nineteenth century and in new worlds across the seas.

The episcopal or cathedral city is a development that ensued on the settlement of population. The Church planted itself and generally spread its architectural roots within a precinct. St. Paul's in London, like the cathedral in Florence, always possessed the character of a municipal church. Westminster itself was the enclosure of the royal palace grounds and its monastery lay concealed under the southern shadow of the minster. The great church took up a position within the city, secure but not necessarily central—in it, but not of it, fulfilling by example the authentic relation of the Church to the world. Some of the cathedrals dominate their cities from sites having the character of an acropolis, as Durham or Lincoln; but Canterbury, York, Winchester, Chester or Gloucester illustrate the more general position in relation to the town. The scale and beauty of the building is predominant, and in every external aspect makes the vision of the city. Turner, the painter, truly said that St. Paul's was London; but, as a rule, the civic centre of vitality in England is side-tracked into a market-place or town-hall street, and we should feel, instinctively from association, that a city planned with the cathedral as its centre, though the building would be naturally the largest and most beautiful, is un-English in expression. Architectural emphasis and civic requirement did not coalesce in the Middle Ages; the Church provided the former out of its absorbing vigour and wealth, and the practical business of the community humbly and contentedly went its own way. Economy of site within walled cities ensured freedom as to heights and projections; streets converged upon irregular market-places that they did not cross, and internal development was innocent of the virtues or drawbacks of symmetry, useless width, or ordered dignity. The castle, sometimes the nucleus of the community and situated on its edge, was the point from which the circumvallation began—of this London, Chester, Oxford, Rochester and Norwich are typical; the rest looked after itself.

The mediæval town hall in England, in which was concentrated the council, justice, and administration, is nearly always on the most economical scale. It is difficult to collect examples, and fundamentally wrong to compare them with the palaces of government of the free cities of the Continent. Beside the guildhalls of London, Winchester and Coventry the rest are unimportant, though small and interesting specimens of mediæval and somewhat later guild and market halls are sprinkled over the country, as at Shrewsbury, Peterborough,

Rochester, Wallingford, Ledbury, and more minute ones at decayed ports like Aldeburgh, and Fordwich, near Canterbury.

The Great Hall of the King's Palace at Westminster—an example almost without rival in Europe—absorbed in practice the national government, and must suffice for our pride, though in no way complying with any prescription of plan in relation to town development.

The civic palaces of the Italian free cities, of the Low Countries and of Germany are the expression of a different political system, and each country furnishes a remarkable and significant group. These can only be generally referred to, but in themselves and their relation to their town they are eloquent of a noble municipal pride and witness to historic conditions of freedom and patriotism that is unreflected in the cities of the kingdoms of France and England.

Florence, Sienna, Perugia, Padua, Pavia, Verona may be instanced from Northern and Central Italy. Sismondi waxes into enthusiasm over the political freedom of Lombardy and Tuscany expressed in the building of the towns of the thirteenth century ("History of the Italian Republics," Every-man Edit., p. 98): "The cities, surrounded with thick walls, terraced and guarded by towers, were, for the most part, paved with broad flag-stones; while inhabitants of Paris could not stir out of their houses without plunging into the mud. Stone bridges of an elegant and bold architecture were thrown over the rivers; aqueducts carried pure water to the fountains. The palace of the *podestas* and *signorie* united strength with majesty. The most admirable of those of Florence, the Palazzo Vecchio, was built in 1298. . . . . The prodigies of this first-born of the fine arts multiplied in Italy; a pure taste, boldness and grandeur struck the eye in all the public monuments, and finally reached even private dwellings; while the princes of France, England and Germany, in building their castles, seemed to think only of shelter and defence . . . . Italy, ennobled by freedom, enlightened the nations, till then sunk in darkness." The municipal fervour competed with that of neighbouring cities in ecclesiastical as well as civic building. Of this the Duomo at Florence is the most remarkable instance. Successive attempts, not merely to extend its area and adjuncts, but to increase its dignity and height, resulted in the enormous octagon which proved too big to vault until Brunelleschi's engineering genius created the cupola, the formative ideal of its child Michel Angelo for St. Peter's at Rome, and which descended to us generations afterwards in the dome of St. Paul's.

Flanders at the opening of the fourteenth century was developing wealth through the cloth trade of its towns, of which Ypres was the centre. The great hall of the linenworkers was and remained the greatest municipal commercial building in Europe, the first place of exchange for the luxuries of the East with the coarser materials of the West—a monument of premier importance in the history of commerce. To Ypres succeeded Ghent, where the English alliance between Edward III. and the burgher Jacob van Artevelde was consolidated (remembered by the birth in that city of Edward's son, John of Gaunt), a city founded on a practical commercial basis in an age of feudalism. The town hall, the belfry—the token of chartered freedom—and the ample public places indicate the size and wealth of the city. Ghent, or Gand, was the glove into which Charles V., in the next century, said that he could put the Paris of Francis I. To Ghent succeeded Bruges, partly through the failure of water transit to the former (now revived at Zeebrugge), where a noble civic pride can still point to a supreme belfry and market and town halls. The rich and beautiful town halls of Brussels and Louvain in the fifteenth century, and the foundation of the university in the latter city, are evidences of civic growth based upon commercial prosperity—evident also in the town halls of Oudenarde and Courtrai. The development of Antwerp, with its great civic cathedral, followed; it rapidly became the seat of a wide sea-borne trade whose port 500 light vessels daily entered and left. The predominant size and wealth of these cities in the European scale can be well estimated from their municipal buildings.

The free cities of Germany are on a smaller scale than those of the Low Countries. The Rathhaus has its central position in the irregular square or market, at once picturesque and dignified, and as often simple as enriched with detail. Lübeck, Cologne, Brunswick, and Regensburg are examples, with the smaller but almost uniquely complete town of Rothenburg. The mediæval system of town fortification still remains around the last-mentioned town, with the modern galleries and stairs to the walls and gateway towers; they now provide pictures of delusive attractiveness to the architectural sketcher, but are pathetic reminders of the predominant nuisance of wars and sieges to civilised life.

Meanwhile the Middle Ages witnessed the evolution of the front or elevation into a self-contained architectural composition which became a constituent in the design of a street. This was a new and real development of civic art unknown to the ancient world; it provided the means for co-operation between the separate or private buildings of a town to produce a combined result, and from this discovery civic architecture will not separate herself until every thoroughfare is in a tube. The vigour of Gothic architecture is due to its freedom and unsophisticated variety in expressing the mechanism of building. Compulsory harmony is alien to its spirit, and this doubtful blessing street architecture owes to a later historical period, and the application of a doctrine of uniformity was not one of the first fruits of the Renaissance that ensued in the fifteenth century in Italy with the conception of a street as a composition. The philosophical architect may well be amused or annoyed with a dogma that compels free citizens to pretend a classic agreement of external countenance to their houses denied by internal construction.

The maxim may be proposed that in the interest of Gothic remains their beauty consists, and that the charm of this interest is due to directness of purpose: every honest effort, even when superseded, retains this character, which eludes and defies a superficial imitation. So far as this maxim applies to the picturesque appeal of mediæval features, civic architects commissioned to design gateways, bridges and park furnishings need to be reminded of its application. The chartered idealist may trespass from the path of pure reasonableness in design, for in the pursuit of illusion he sacrifices any claim to assist the realities of modern life. To some extent the architect in designing elevations and in the creation of detail is dependent upon antiquarian or even archaistic suggestions; but the town-planner, however he may be tempted to discern scientific law in the accidental crookedness of a mediæval city, cannot subordinate the convenience and directness demanded by a modern community to any theory of the authority of the picturesque.

COTTON CULTIVATION IN CHINA.

The *London and China Telegraph* draws attention to a pamphlet dealing with the question of cotton cultivation in China, published by the North China Daily News and Herald, Ltd., Shanghai. In this the question of cotton cultivation in China is dealt with in a very compact and convenient form. It will probably surprise many people to learn that China ranks third among the cotton-producing countries of the world. The average crop of America is between thirteen and fourteen million bales, that of India about four million bales, and that of China is conservatively estimated to be in the neighbourhood of two million bales. Unfortunately there are no statistics concerning the cotton grown in China, so that no positive statement can be made as to the acreage under cotton cultivation. In the usual Chinese fashion there seems to be no order or system. Cotton is planted, say, in a given district, then beans, then cotton again, and so on; but the estimate of production given above is thought to be nearly correct. As the writer of the pamphlet says, if any real effort is to be made to better the quality of Chinese cotton and to increase the yield per acre, it will not only be interesting, but most important to know, first of all, the approximate acreage now under cultivation. Such figures, he suggests, could be obtained by the Chinese Department of Commerce, or Agriculture, were those departments of the Government induced to take an interest in the matter, as the information could be got by means of reports from the various *lekin* and tax offices throughout the country. That China could be made the leading cotton-producing country of the world is, he says, no wild statement. Experiments made in the vicinity of Shanghai during the past few years show that the yield per acre can easily be increased threefold simply by selecting seed, by preparing the land in advance of planting, by the use of bean and other fertilisers within the means and reach of all Chinese farmers, and by properly weeding and caring for the plant from planting time until the plant has matured. The yield per acre could be trebled under ordinary scientific cultivation, and there is practically no limit to the extent to which the acreage might be increased.

What is needed is Government action. The author makes suggestions as to what direction it should take. He states that by using the services of trained cotton experts, and by the wise expenditure of money, the Chinese Government could greatly improve the quality and quantity of Chinese cotton, thereby enriching the country and the people and benefiting greatly the cotton industry as a whole. This could be done by the establishment of Government experimental farms in the various cotton-growing districts of China. By experimental culture and the adoption of plant selection and seed selection, by experimenting with fertilisers, it could be determined which particular plant is best suited to a particular locality—details we need not dwell upon. Although it may be too much to expect that the Government would do so from the very beginning, to carry out the work

thoroughly would mean the opening of experimental farms, each of about 10 acres (60 mow) at ten or twelve centres, but if a start were made with half that number much good work could be done. The farms should all be linked together under one system with one head in control, a foreign chief cotton expert who would have full charge of a cotton culture department of the Department of Agriculture. Every other cotton-growing country in the world has its experimental farms, and China to-day stands alone as the one country that does nothing towards bettering the quality or increasing the yield of its cotton. There is reason to believe, however, that the Government is alive to the importance of the matter. Since last year an American cotton specialist was engaged by the Ministry of Agriculture to start an experimental cotton culture farm. This, at any rate, is a beginning, but how far he has proceeded with his work is not yet known. As the author of the pamphlet observes, whether the desired end will be attained depends much on the authority given him. If he is given a free hand it is safe to state that some worth-while things will be done; but if he is handicapped, as foreign employees of the Government usually are, with no real authority of his own, the outcome is entirely problematical.

THE TUNGSTEN DEPOSITS OF ESSEXVALE, SOUTHERN RHODESIA.*

There seems to be a general opinion that the tungsten deposits at Essexvale consist only of so-called alluvial or rubble wolframite, and that reefs have not been found. This is not true. Some reefs have long been known, and the excavation of the rubble has led to the uncovering of others, which, so far as can be judged without actual sampling and development, offer good prospects for mining. But hitherto there has been a strange reluctance to undertake mining operations on the reefs, whilst the work on the rubble has been largely desultory.

POSITION.

The known tungsten reefs lie within an east and west rectangular block of country of about nine and a half square miles area, immediately to the north of Essexvale Siding and mainly west of the railway. The reefs extend from the neighbourhood of "The Ranche" (2¾ miles north-west of the siding) to the native church (1½ miles north-east of the siding). Sixteen distinct reefs are known, eleven of which have had a little work done on them from time to time.

HISTORY.

The deposits were first prospected in 1906. In the ensuing two years a fair amount of ore was produced, but in 1909 the production ceased. A little interest was again taken in the deposits in 1912–13, but there was no production in 1914–15. At the end of that period a local syndicate extensively sampled some thousands of tons of rubble and made trial crushings. The grade was found to be just too low for profitable working by the methods then employed. During 1916, however, determined efforts have been made by other workers to test the rubble of two restricted areas.

Altogether about 85 tons of concentrate, valued at £7,165, has been marketed. The returns for 1916 are 2¼ tons, valued at £467. This was produced by one worker with a few natives in a 5-ft. rotary diamond washer, and by one man on another claim, who hand-picked rubble and recovered 1,600 lb. of wolframite.

The prospecting done on the few reefs that have been opened has nowhere been for more than a few feet below the surface. This may be due chiefly to the fact that the deposit upon which serious prospecting work has been undertaken is from its nature the least likely to prove profitable.

GEOLOGY.

The known tungsten-bearing tract of country occupies the central portion of an irregularly oval mass of granite about 8 miles long and 5 miles across at the widest part. The long axis of the mass trends north-west to south-east. This granite body forms the floor of a wide depression which is traversed by two permanently flowing streams, one of which is known as Fern Spruit. The granite appears to pass beneath the surrounding rim of epidiorite and felsite hills. The soil is a pale red sandy loam. There are very few exposures excepting in the streams and an occasional small but bold granite kopje. The granite almost wherever seen is coarse-textured and massive—that is, not schistose. It is a hornblende granite, and is thus different from the large granite masses of Rhodesia. Patches of epidiorite, probably inclusions of country rock, and dykes and other bodies of felsite are occasionally encountered, particularly near the eastern edge.

THE REEFS.

The tungsten reefs consist of greisen composed chiefly of a soft greenish-yellow mica, or of mica, fluorspar, topaz and secondary felspar. This rock weathers soft and rusty brown. The greisen has arisen by the action of vapours on a porphyry or aplite (fine-textured white granite free from hornblende and mica). With the greisen of each reef is a variable amount of rather white glassy quartz forming strings or large lenses in the greisen, and evidently connected with the greisenisation—that is, deposited at the same time and by the same agency as the mica, fluorspar, topaz, tourmaline, chlorite, wolframite, and scheelite of the greisen.

* Reprinted from the *Bulawayo Chronicle*, May 18th, 1917.

The constant presence of the quartz lenses as part of the greisen bodies is a great help in recognising the presence of the greisen. Those parts of the greisen which contain little or no quartz very rarely crop out, and thus may easily escape discovery. No tungsten reefs have been found without the quartz, although it is quite conceivable that such exist.

The quartz strings expand into lenses exceeding 20 ft. in width, and thus make low hillocks such as those at "The Ranche" homestead; again two-thirds of a mile to the south-east of this, and at the native church a mile and a half north-east of Essexvale Siding.

The reefs vary from 200 yards to about a mile long. The two most promising reefs exposed are respectively about a mile long and half a mile long so far as proved. These are the Rhoda reef in the north-eastern portion of Plot 27, and the reef running through the Lunar and Moon blocks near the common boundary of Plots 37 and 38.

With one exception the reefs examined strike east to west and dip north at angles varying between 30° and 55°. The reef on Plot 4 strikes north-west to south-east and dips north-east at 53°.

The width of the reefs is, of course, variable owing to the lenses of quartz. Apart from the quartz lenses, the width averages three feet and is surprisingly constant.

In each instance the country is coarse massive hornblende granite without signs of shearing or faulting between the reef and the country. It appears, therefore, that the aplite was injected along master joint planes caused by the contraction of the granite on consolidating, and not in fissures caused by faulting. This may have an important bearing on the persistense of the greisen bodies below the surface. In a few instances the mica greisen has a slightly schistose appearance. In a few places greisenisation of the country is suspected, but this is on a small scale only, and no tungsten ore has been discovered in it.

With the exception of the Union Jack reef in the north-west corner of Essexvale Reserve, the aplite has been completely greisenised so far as can be judged by the small amount of reef exposed. At the Union Jack the intrusion exceeds 6 ft. in width, but about a third of it consists of white aplite apparently ungreisenised.

Stockwork Deposit.

The block upon which most work has been done differs from the above blocks, which may be taken to be normal. The occurrence in question is situated on Tungsten Kopje, a prominent hill of massive hornblende granite with a low ridge extending about 300 yards to the east and a longer one to the west.

The fact that a large amount of float wolframite occurred immediately around the hill led to prospecting on the hill, with the result that a stockwork deposit was discovered extending along the eastern and western ridges and on the north flank of the hill.

Throughout the massive hornblende granite of this zone streaks and seams of aplite containing gashes of quartz are scattered rather sparsely and quite indiscriminately. These seams run in all directions and at all angles; many are nearly flat, but some are vertical; they make small saddles in several places, but, pursue irregular courses, and expand and die out quite irregularly. They average a few inches wide and in no instance exceed a foot. None are traceable for more than a few yards. The greisen always carries streaks of quartz and occurs on one or both sides of the latter. The aplite varies in degree of greisenisation. In some parts the greisen consists of sugary quartz and pyrite with very fine wolframite scattered through it but invisible to the naked eye. Such a rock weathers brown and strongly resembles sandstone. It is always present in the rotary concentrate. In other parts the greisen consists chiefly of a soft yellow mica.

At the south-west end of this deposit a body of greisen about 6 ft. wide, striking north to south and dipping about 40° E. has been opened and afforded rich patches of wolframite.

Minerals of the Greisens.

The minerals detected in the greisens comprise quartz, soft yellow mica, felspar, dark green chlorite in rosettes, black tourmaline, pyrite (altered to cubes of limonite at the surface), fluorspar (blue, mauve, green, white and colourless), topaz (pale brown and colourless), galena (rather rarely), pyrrhotite, wolframite and scheelite.

Small quantities of each of these occur in the quartz. Here and there a bunch or streak of any one of them, including the tungsten minerals, lies in the quartz. The distribution of the minerals in the quartz or in the altered aplite is, in fact, generally patchy, as is always the case in greisens. Coarse aggregates of any one mineral are occasionally noted—for example, single aggregates of very large wolframite crystals weighing 235 lb. and 157 lb. are said to have been found at the stockwork deposit, and similar groups of crystals have been obtained at the Lunar Block (the specimen in the Rhodesia Museum weighing 172 lb. coming from here). Pieces of wolframite weighing up to 8 lb. are not uncommon, and groups of pale pinkish scheelite crystals measuring 3 in. or 4 in. are to be found. The two tungsten minerals are commonly intergrown; but in spite of this and of the fact that scheelite, containing, as it frequently does, several per cent. more tungstic oxide than wolframite, may be worth several pounds sterling per ton more than the wolframite, it was found that the scheelite was

neglected by the workers—in fact, considerable trouble was taken by them to separate it from the wolframite and reject it.

Scheelite is a mineral very easily recognised, and the natives engaged in panning the concentrate should be taught to know it. Although it is not unlike quartz so far as colour is concerned, being white, pinkish or yellowish, its characteristic greasy lustre, softness (it is easily scratched by the knife or by quartz), and heaviness are properties which differentiate it sufficiently from any of the minerals with which it is associated. If boiled in dilute hydrochloric acid it becomes coated with bright yellow powder soluble in alkali.

Among the dark minerals got in the concentrate, magnetite may be recognised (and separated) by the magnet, and limonite by being in brown cubes. Coarse and moderately fine wolframite is easily distinguished from the other black minerals by its greater specific gravity and chocolate-brown streak; it breaks into flat slabby pieces with lamellar structure owing to the presence of a single perfect cleavage; the flat surfaces are bright and shiny (submetallic to resinous lustre), whilst the cross fractures are dull. Ilmenite, which is rather abundant in very fine round grains in the concentrate of the rubble, is difficult to distinguish from fine wolframite by simple tests, and this fact had led to the rejection of the finest concentrate.

Mineralisation.

In addition to the minerals common to greisen, the presence both in the stockwork and in the veins of galena, pyrite, pyrrhotite and presumably gold, together with the large amount and constant presence of a kind of quartz which is indistinguishable from the ordinary vein quartz of gold deposits, suggests that the Essexvale tungsten deposits are not normal greisens, but to some degree assume the characters of the gold-quartz vein type of deposit. In fact, they appear to form a connecting link between the two types. This theory is borne out by the character of the mineralisation of the country rock alongside the greisen streaks in the stockwork deposit. The rock is pyritised (pyrite and pyrrhotite), and the felspars altered to sericitic aggregates.

The Rubble.

The richer patches of rubble lie within 100 yards of the greisens on the steeper ground and within about 25 yards on the flat ground.

Tests of this rubble indicate that the yield of wolframite (the scheelite, as noted above, being rejected) varies from 2 lb. to 8 lb. per ton. In this estimate the occasional lumps of coarse wolframite are not included, and fine wolframite and scheelite in lumps of rock and free are also not included, since they are rejected.

In the instance of the western end of the Lunar Block reef, it was stated that early in 1916, 1,600 lb. of wolframite was picked up from the surface by hand without any appliances, without even a prospecting pan, notwithstanding that the ground had been broken, turned over and picked on at least one previous occasion.

Where the rubble is being more thoroughly tested, the ground, made up of angular quartz fragments, brown-weathered greisen and sandstone-like aplite in a matrix of red loam, is hand-jigged on rocking screens, the coarse wolframite being hand-picked from the screens. The fines are concentrated in a 5-ft. rotary diamond washer, which recovers the tungsten minerals and even the fine heavy minerals. The concentrate is then panned by hand. The coarse wolframite (pieces over ½ in.) are picked by hand and the fines repanned. Any coarse wolframite with adhering quartz is pestled and panned. The coarse and medium concentrate so obtained is remarkably clean wolframite. The finest concentrate consists of wolframite and scheelite, with a certain amount of quartz, felspar, epidote, hornblende, mica, zircon and tourmaline, together with a trace of gold, and a fairly large quantity of ilmenite, limonite cubes, and magnetite. The finest concentrate is rejected under existing circumstances, but on a larger scale of operations concentrating tables and magnetic separators may be expected to give profitable results.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Enemy's Supplies.—A manifest sense of helplessness overtakes German writers when they contemplate the future of their textile industries after the war. Their mills require, upon the old basis, rather more than one million tons of raw material per year. Of this quantity 86 per cent. has been obtained from countries with which Germany is at war, and 83 per cent. has come in by sea. If there were no other obstacle than that of shipping, German industry would be hampered for a long time after peace. There is the depreciation of the mark to consider as well as the deterioration of industrial machinery, and again the consequences have to be reckoned with of the policy that led the German authorities to strip and wreck the French textile mills. It is noteworthy that not much mercy is expected by Germans in surveying the plight. Besides the dependence for raw material, Germany has been dependent upon other countries for yarn worth £30,000,000 at old prices and at the old rate of exchange. There is no comparable dependence upon the other side. Turkish mohair, Belgian and a certain amount of Russian flax are among the materials upon which the enemy has set his hand, but to these there are alternatives, and to the necessary 950,000 tons of cotton, wool, jute, flax and so forth Germany has none. The textile

position is possibly the strongest single cause of the enemy's fear of economic isolation.

Cotton Research.—The decision of a great Lancashire firm to set aside £10,000 a year for five years for the purposes of scientific research and education is quite the most robust evidence of faith thus far noted. The Tootal Broadhurst Lee Company's example necessarily makes a mark upon the minds of other leaders in the cotton industry, and it should dispose finally of parsimonious promptings or of inclinations to half-do the work. The business of raising a fund for cotton research has begun, and the programme mapped out for the Research Association includes four principal heads: the collation of reports upon the scientic work already done, the founding "somewhere in the British Empire" of a cotton-growing experimental station, the establishment of laboratories for research into manufacturing processes by men borrowed from other institutions for the purpose, and the foundation of a separate research institute with its own staff of experts. The scheme conflicts with the opinion of those who hold that the universities are the proper custodians of applied as of pure science and the natural guardians of scientific industry. The scheme seems to provide for the employment of assistants of university training, and for the occasional services of members of university staffs. Upon these terms the relations between institutes controlled by traders and universities under other control may be both intimate and fruitful. The more heavily that manufacturers finance research the more probable it is that they will wish to retain its administration in industrial hands.

Lacunæ.—The cotton industry, although it has risen to gigantic proportions as a manufacturing business dependent upon mechanical science, has had no adequate provision at all for its due nourishment with the knowledge which makes new improvement practicable. It is pointed out by the Provisional Committee for Cotton Research that nobody knows precisely what takes place internally in the cotton fibre in its progress from machine to machine. In consequence the cotton grower does not know what to grow for, beyond such characteristics as length, fineness and colour of fibre. More or less all cotton manufacturing involves the use of starch, but it has been nobody's business to know all about the starches. Clever brains have been devoted to the operation of bleaching, but sooner or later every bleacher is brought up short against the unknown. Men weigh cotton, but the smallest weight in trade use is equivalent to 10,000 to 20,000 single fibres. The greatest refinements even of present-day laboratory practice are rough, and it is not until that which lies beneath the unknown is discovered that progress in new directions can commence. To impress upon practical manufacturers a sense of the crudity of their methods without frightening them by the abysses disclosed into a conviction that science is all vagueness and uncertainty is not too easy a task. No results can be guaranteed, and money alone cannot ensure them; but the consequences of leaving undone the work needed to facilitate new developments are imminent enough to be sensed.

Mr. Warner's Appointment.—The retirement of Mr. Frank Warner from the presidentship of the Silk Association would give more concern were the retirement into private life. Happily the removal is to a higher sphere of utility in an honorary post under the Board of Trade, where Mr. Warner will give to textile industry at large talents that have been devoted hitherto chiefly to one section. The appointment follows upon his work upon the committee formed to consider the position of textile industry in relation to the war, and may be said to arise out of the desire to carry the recommendations of that body into effect. In addition to whatever else the position may involve, it will obviously bring the occupant into close relations with matters in which Mr. Warner has demonstrated an abiding interest. Technical and art education and the cause of textile research are not likely to suffer from any neglect from which Mr. Warner can save them. Nobody's experience is universal, but Mr. Warner's is at any rate comprehensive, and a manufacturer with wider sympathies and understanding would not easily be found.

Patent Stockings.—Little comes of attempts to improve the accepted models of clothing. People invent coats that can be converted into long or short ones at will, or that can be reversed and worn inside out, but nobody wears them. Even the cloaks that are at will capes, blankets or tents find no steady market. The reason may be over-elaboration and the indisposition of the individual to take the trouble expected of him. Overcoats built up of several layers which may be diminished at will are used in the sedentary conditions of trench life, but otherwise the form of our garments seems settled beyond shaking. The stocking is perhaps the most firmly fixed type of apparel, yet an inventor has devised for military use a two-ended stocking. The top becomes the toe or the toe the top as desired, either end being closed by a tie of yarn. The object is to double the life of the sock by changing the wearing surface, and provision is made for several patterns, bent or straight, with single or alternative heels. The socks are no more sightly than the standard pattern, but they may have advantages to campaigners shod in oversea boots.

Neo-Antiques.—Since it has been thought worth while to patent in America a process for giving textiles an antique look, a certain demand for articles having a semblance of antiquity may be assumed. The appearance should not be hard to get, and in some cases might be obtained merely by neglecting the pains ordinarily taken to freshen

and smarten naturally frowsy productions. Makers of pseudo-antique rugs in the East are understood to employ coffee-stains and candle-flames as accessories, and to obtain some guaranteed wear by leaving their rugs for the traffic to pass over. In a matter so far outside regular Western experience the best means to adopt may be debatable, but the patented American system seems to provide for a sufficient degree of fading. The inventor would perhaps not claim originality for his combined bath of caustic soda, bisulphite and peroxide of sodium, all of which are in common use by finishers. The use of chlorine water to clear the whites and the eventual washing and blueing are scarcely novelties in textile practice, although it has to be admitted that their regular use has a diametrically opposite object to that of simulating great age.

OBITUARY.

ANNE LEE-WARNER.—Miss Anne Lee-Warner died at Woodford Green, Essex, on the 27th inst., at the age of seventy-seven. The second daughter of the late Canon H. J. Lee-Warner, she was a sister of Sir William Lee-Warner, G.C.S.I., who served for many years on the Council of the Royal Society of Arts, and was Chairman of the Indian Section Committee. In consequence of her brother's close connection with the Society, Miss Lee-Warner became much interested in its work. She was elected a Fellow in 1914, and was a frequent attendant at the meetings. She shared to no small extent the singular charm of her distinguished brother, and she was very popular among all with whom she came in contact.

GENERAL NOTES.

WHALING INDUSTRY IN JAPAN. — Whaling in Japanese waters, according to a report by H.M. Commercial Attaché at Yokohama, is carried on under licence from the Government. The number of whalers is restricted to thirty, of which one company owns twenty-four. There is little prospect of the number of whalers being increased at present. The whalers are steam vessels of about 100 to 150 tons, and are built after the Norwegian whaling type. They carry a crew of from twenty-five to thirty, the gunners being mostly Norwegian. The boats seldom venture more than 50 to 60 miles from land, and only remain out a day or so at a time. They are not equipped to extract the oil on the boats, and therefore the captured whales have to be towed to port. About 15 to 20 per cent. are lost through various causes—*e.g.*, storms and breaking of ropes. The varieties of whale mostly caught are the sperm and sulphur bottom. According to figures supplied by the Fisheries Bureau of the Japanese Department of Agriculture and Commerce, the estimated number of whales caught in 1916 was 1,400, valued at 1,150,000 yen, as compared with actual catches of 1,710 whales in 1915, valued at 1,064,809 yen, and 1,700 in 1914, valued at 1,412,468 yen. The approximate yield of whale oil in Japan is stated to have been 2,500 tons in 1913, 4,500 tons in 1914, and 5,500 tons in 1915. About 5,000 tons is considered a safe estimate of the production in 1917. The process of rendering the oil, whilst effective as regards the quantity obtained, is crude and unsatisfactory as regards quality. It is stated that the company referred to above—which, in addition to whaling operations, itself renders whale oil—may possibly undertake the hardening of the oil instead of selling it to be refined, as is done at present. The main uses to which the oil is put are for making soap, lamp oil, machine oil, margarine, tanning materials, and hardened fish oil.

SWEDISH MARINE WAR LOSSES.—According to a statement issued by the Kommers Kollegium of Stockholm, the direct losses sustained by the Swedish Mercantile Marine through war causes since July 31st, 1914, amount to 136 ships, of 125,000 gross tons, of which 94 were steamers aggregating 110,000 tons, and 42 sailing ships of 15,000 tons. By far the greater part of these were sunk by U-boats and mines. During the first six months of 1917, 45 ships have been lost, of which 32 were steamers and 13 sailing ships. Of ships over 1,000 tons 20 have been sunk by submarines. In addition to these losses a considerable number of steamers have been arrested. Five have been condemned, and about a dozen cases are to be tried in the Prize Courts.

IRON AND STEEL INSTITUTE.—The Autumn Meeting of the Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, September 20th and 21st, 1917. The following is the list of papers that are expected to be submitted for reading and discussion: (1) G. Barrett and T. B. Rogerson, "Present Practice in Briquetting of Iron Ores." (2) W. J. Brooke and F. F. Hunting, "Microstructure of Commercially Pure Iron between Ar_3 and Ar_2." (3) E. D. Campbell and W. C. Dowd, "The Influence of Heat Treatment on the Electrical and Thermal Resistivity and Thermo-electric-potential of some Steels." (4) G. Charpy and A. Cornu-Thenard, "New Impact Testing Experiments." (5) J. E. Hurst, "Heat Treatment of Grey Cast Iron." (6) E. F. Law, "Effect of Mass on Heat Treatment." (7) T. D. Morgans and F. Rogers, "Investigation upon a Cast of Acid Open-hearth Steel." (8) F. Rogers, "The Acid Open-hearth Process." (9) J. H. Whiteley, "The Eggertz Test for combined Carbon in Steel." (10) E. B. Wolff, "Failure of Boiler Plates in Service and Investigation of Stresses occurring in Riveted Joints."

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

CIVIC ARCHITECTURE AND TOWN-PLANNING.*

By PROFESSOR BERESFORD PITE, F.R.I.B.A.

Lecture III.—Delivered February 12th, 1917.

THE RENAISSANCE AND THE NINETEENTH CENTURY.

The period of four centuries from the advent of the classical Renaissance in Italy terminating at the French Revolution links the ancient with the modern world. It began with an intellectual movement, mainly expressed in religion and art, and closed with the social and political upheaval to which, after the interval of another century, our present concern with town-planning is due. Throughout the epoch the ideals of the artist, on the whole, took a uniformity of aspect and slowly lost strength, while the political and social elements, permeated by religious freedom, fitfully gathered force. The action, co-operation or rivalry of these influences may be inferred or discerned in the civic developments of the period, but all the considerable experiments and advances within its limits are generally due to a personal initiative that employed architecture for monumental display. To such a generalisation there are, however, important exceptions in many directly beneficial works that we have, with the development of the social sense, learnt to describe as public improvements. This individual promotion of civic architecture was due to the action of some of the popes in Rome; in France generally to the monarchy growing in wealth and influence, and always sympathetic to artistic motives; in a less measure in Spain and Germany to the emperors and minor potentates; while in England, where but little was attempted, architectural progress was almost wholly due to the enlightened part of the unsatisfactory characters of the Stuart dynasty.

The architectural character of the epoch was settled by the renaissance of Roman art. Throughout Europe, as indeed also in the freshly colonised West Indies, a placid contentment with the revised classicism of ancient Rome is universally exhibited. Palladio's studies and published plans of the forums, temples, baths and palaces provided motives for architects, and his followers emulated and reprinted text-books of uniform civic architecture that had a wide and continuous circulation. The enthusiasm for scholastic architecture, as a fine or unrelated art of expression, resulted in an affectation of style and pompous grandeur that extended its influence to the limits of the ridiculous. Christian temples and ecclesiastical palaces were erected in the Roman manner, their surroundings were idealised into forums; public squares and their approaches were treated on so-called classic lines, and presently the whole of a town became the subject of an artistic design.

But the period under review was only artistically great, enthusiastic and generally fruitful, at its commencement—during a time of unrest, invasion and disturbance in Italy, that was necessarily inimical to extensive public works. It is not easy to connect the spasmodic manifestations of genius with other parallel national movements, though the hasty deduction might be made that meteoric appearances do not usually occur in the settled weather of political calm; they seem to fall near the threshold rather than at the central or culminating epochs of social progress, and appear to be generated amidst the heat of revolutionary unrest and upheaval. Of this want of relation to peaceful times, the outspringing of the fine arts of painting

* The course consisted of four lectures, delivered on January 29th, February 5th, 12th, and 19th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into six parts.

and sculpture in Italy, or of landscape painting in England, may be illustrations. The masters of these arts were, in their exercise, personally independent of the stormy political atmosphere, but the architecture of great public works necessarily waits for the quiet of prosperity and social calm, when the secret volcanoes of inspiration and enthusiasm that seem to generate the mysterious stimulus of artistic motive and instinctive design are quiescent. The greater scale of the work of civic building and town-planning demands a large measure of genius, and the lack of this inspiration became apparent in the schemes that were initiated and carried into execution in Europe, while the extensiveness of the undertaking always attenuated the artistic quality. The decay and neglect of indigenous or native building art, characteristic of race and clime until the close of the Middle Ages, profoundly affected the mass of buildings that constituted the towns, and the possibilities of a general civic architecture altered accordingly; in its earlier phase the Renaissance had combined an artificial illumination with the evening light of the Gothic world, but the developed enthusiasm of Palladianism eventually left all architectural art dependent upon scholarship. In the result great schemes fell short of any true and complete artistic effect; a noble and original plan for laying out a quarter or town was too often unsupported by an architecture competent to justify its pretension; the art of the elevation failed to support the plan; the artistic strain weakened, and we are conscious, as at Versailles (where success is nearer owing to the genius of the architect, J. H. Mansart, than at first appears), of the failure to supply architectural beauty to a really dignified plan. Many Continental cities supply similar examples of this onesidedness of design, and it would scarcely be saying too much to include all the ingenious town-planning of the eighteenth century under this criticism; the activities of German builders in complete examples at Stuttgart and Carlsruhe, as well as quarters of Vienna and Dresden bearing witness.

An important deduction may be drawn from the artistic failure of large schemes of town-planning and improvement in the period of the later Renaissance, namely, that the constant maintenance and cherishing of a school of architectural art, general as well as specialised, is a civic necessity; a requisite to wait upon and justify schemes of municipal improvement and development; for without a simple and sufficient architectural quality great public places and important thoroughfares lose their proper character, and may be doomed to ignominy. The French Government, under the Grande Monarque, realised this necessity, and by the statesmanship of Colbert established an academical system that has secured a notable maintenance of a high national artistic tradition in civic architecture in France.

The judicious and observant student of history, who seeks to describe and estimate the forces operating in the social life of an epoch, will find in civil and domestic architecture concrete evidence of aspects of the nature of public and of intimate life; but until the French Revolution town-planning as practised was scarcely an outcome of social development. The highly intelligent traveller, Arthur Young, visiting France in 1787 for the purpose of agricultural observation, writes that he knew "nothing in which our expectations are so horribly disappointed as in cities, so few are built with any general idea of beauty or decoration." On the impressive provincial chateaux of certain noblemen he comments that "these ministers would have sent the country to the devil before they would have reared such edifices, or formed such establishments, if they had not been sent from Versailles" (that is, dismissed); and on the dwellings of well-to-do citizens, that the spectacle was extraordinary for English eyes of "good houses without glass." These are significant indications of that new aspect of the subject in the public mind, which slowly but steadily during the nineteenth century has connected social progress with town-planning, and recognised in it a voice to which public opinion will attend. The architectural impetus is now replaced by that of sanitary and social reform; the fading of the artistic ideal from the general vision is not a little owing to defective education, as well as to the sterilising of building art by architectural professionalism; but from whatever cause the evil of a new onesidedness, through the neglect of civic architecture in town-planning, is real, for beauty, as a manifest source of daily pleasure, has a value that should not be authoritatively overlooked. This is not a question of the pre-eminence of either sanitary or artistic principles, but of wisdom in their combination by a just appreciation of mutually essential services.

THE ROMAN RENAISSANCE.

Throughout the long millennium of the dark and Middle Ages the city of Rome was in a condition of progressive decay, and by the

fourteenth century the population, which in the heyday had approached two millions, dwindled to a remnant of about twenty thousand. The hills had become generally deserted, and the monumental areas were avoided by the inhabitants, the city settling in a squalid mediæval way in the Campus Martius near the Ghetto and the river, and in village-like groups dispersed over the wide area enclosed by the ancient walls.

The civil government had been generally futile, incessantly disturbed by the factions of Guelphs and Ghibellines, and by the contentions of the Popes and nobles. The sentimental enthusiasm of Rienzi for the revival of "the good state" of the ancient Roman Republic flickered out from want of genuine force after a temporary municipal reform during the absence of the Popes, and the idea of a so-called Babylonian exile at Avignon from 1309 until 1377 summarises the depression that had ensued upon the lack of adequate government, wealth or commerce.

Part of the Capitol, in the background of the mediæval town, was occupied for the House of the Senator, and portions of the ancient Tabularium were used for municipal offices. The palaces on the Palatine, that had been partially occupied by the Gothic kings, had passed out of use for centuries, abandoned to fire and earthquake, and ultimately reduced like the other monuments by quarrying to unrecognisable masses of material. The chief fortress of the city throughout the era was situated upon the basement of the great Mausoleum of Hadrian across the river, upon the wall commanding the bridge from the Campus Martius; the name of S. Angelo did not attach to it until later, it being known as the Castle of Crescentius. Occasionally it became a necessary refuge for the Pope, and ultimately it was united to the Vatican Palace by a corridor behind the wall.

The churches were numerous and traditionally important, the five principal patriarchal basilicas were widely separated and no one of them occupied a central site: St. Peter on the Vatican, at the extremity of distance from St. John on the Lateran, where the Pope resided until the Renaissance; St. Mary Major on the Esquiline, and St. Laurence and St. John without the walls. There was nothing incongruous in a city of pilgrimages in this distribution of interests with their winding routes of communication having some resemblance to Jerusalem, though ultimately presenting a serious problem when street-planning and improvement became an ideal of the Popes. The ancient Sta. Maria della Rotunda, *i.e.* the Pantheon, seems to have served the purpose of a civic church, unconnected with any ecclesiastical establishment, its vast scale and impressive completeness maintaining its pre-eminence; its choice by Raphael for his burial-place testifies to the hold that this monument of the past had maintained throughout the ages.

Rome, unlike other European capitals, had no central mediæval cathedral, the epoch so rich in virile ecclesiastical art is feeble almost to barrenness at its spiritual centre and home. The absence of an exposition of the highest current building art does not seem to have been considered strange or realised as significant in this one city of the Gothic world, where the main interest of life was not progressive. The witness of Christendom at Rome was architecturally negative, the spectacle being offered of broken pagan idols and of a repugnant system, degraded and contemptible, in its terrible ruins; the monuments having gradually lost both tradition and meaning, their architecture faded away without being supplanted or leaving a direct succession.

It is idle, therefore, to seek for a civic architecture in the absence of social order, prosperity or the practice of vital building art, in this the capital of Christendom throughout the Middle Ages; but roots were in the neglected soil, the vital elements of which, suspended and dormant, were not extinct. When the new movement of humanism discovered the intellect of the old world, the architectural genius of ancient Rome, recovered by enlightened and studious excavation, became fresh and active motives in civic design.

The visit of the Florentine artist, Brunelleschi, early in the fifteenth century to study antiquities and his observation of the Pantheon dome in connection with the unsolved problem of vaulting the great octagon of the Duomo of his native city, marks the beginning of the revelation of Græco-Roman architectural detail to the world. As the Renaissance developed, the dignity of the Imperial art of planning became apparent, and the architects were soon affected by its potency. The first applications of the new principles of design were in ecclesiastical and palatial building, but eventually the civic aspect of vast arrangements laid out with dignity was perceived and became predominant. A termination had now been put to the great mediæval era throughout the area of the Western Roman Empire by the discovery

of ancient Rome, and this study and exploration has been pursued with varying ideals and aims ever since. To us its interest is not merely historic or academic, for both the original and the revived architecture supply the civilised world with stimulus and example, and from Rome we practically derive the whole substance of the art of civic architectural study.

The conflicts of political as well as of intellectual and religious interests, their intensity and effect upon European life and art, are reflected in the architectural revival of Rome. The settlement of the Papal schism by the Council of Constance took effect at the dawn of humanism with its new artistic interest. The balance between the power of France and of the Empire combined with Spain and the Netherlands was soon to culminate in the persons of Francis I. and Charles V., and afforded a new political efficacy to the Papacy. The spread of the principles of the Reformation necessitated a purgation and re-invigoration of ecclesiastical life at its centre, and took effect in the operations of the Inquisition and in the foundation of the Jesuit order. Pope Nicholas V. (1447–55) was a Florentine intellectual. He stamped out attempts at civic reform in the city, and, removing his residence from the Lateran, proceeded to establish on the Vatican a palatial home fit to be the diplomatic centre of the ecclesiastical world. The eloquent and philosophical Æneas Sylvius, Pius II. (1458–64), issued a bull forbidding the continued destruction of ancient buildings. Julius II. (1503–13) consolidated the wicked appropriations of the Borgias into the States of the Church, and infused a fresh sense of worldly power and glory into his age. The tendency of such characters and schemes was to seek in architecture the expression of their ideals, and their supreme position gave to their works the influence which dominated European art and building for the succeeding three centuries.

The purpose of Julius II. to place his tomb in the tribune or apse of the basilica of St. Peter was the first occasion of the epoch-making design by Michelangelo, never brought to fruition, and of the Pope's resolve that, in order to enshrine so noble a work, the ancient Apostolic Church should be rebuilt, to effect which he characteristically and promptly destroyed half the venerable structure regardless of its monuments and associations. He had great artists in Bramante—with his school of architects—and Michelangelo—the greatest sculptor of all the ages—at his hand, and we may pause to ask if his destructive zeal has not been justified by his ideals and their ultimate effect.

This great scheme for rebuilding St. Peter's in the beginning of the sixteenth century evoked a design that involved consideration both of the cathedral and its surroundings on a new and large scale. The revived study of Roman architecture suggested a great forum with the temple in the centre, instead of the Christian basilica behind an atrium court. This is clearly the motive of Bramante's original plan for St. Peter's, and it was retained in Michelangelo's scheme.

This architectural burden of the Church, for well-nigh a century and a half, was accompanied by the progressive enlargement of the adjoining Papal palace on a novel scale of magnificence, for which the palaces of the Cæsars afforded the only precedent. Bramante's design, partly realised in the Belvidere and Cortile del Pigna, is fundamentally Cæsarian in its imposition of a great rectangular court upon a site of varying levels subordinated to the buildings. The great oblong enclosure recalls the Circus Maximus, placed astride a valley in which both ascending and descending levels are treated with marvellous skill; the design is self-contained and internal, and is without architectural relation to St. Peter's. The resources of the Popes, though not comparable with those of the original pontiffs or with the dreams of their architects, here achieved a palace that is strikingly Roman both in its ideal of internal splendour and in its disregard of external elevation and dignity.

The revival of historic Rome became an architectural ideal of the new age, not only in borrowing its fashion but by adapting its ruins. Michelangelo had altered the tepidarium of the Baths of Diocletian into a church dedicated to Sa. Maria degli Angeli, and he designed the very interesting and beautiful arrangement of civic buildings upon the Capitol, a result of the zeal of a committee of Roman citizens who sought his professional aid. The wide rising approach, first formed for the visit of the Emperor Charles V., the open quadrangle decorated with classical sculptures, and the related designs of the three façades of the galleries and offices, make a fine architectural composition of real civic expression and importance. The Capitol illustrates sufficiently the value of an ancient motive revived and translated by the genius of a great artist without suggesting the dead hand of an exhumed antiquity, though employing sculptures once full of meaning for the sole purpose of decoration. The bronze equestrian

statue of Marcus Aurelius, hitherto spared because mistaken for Constantine, was removed from the Lateran and placed in the centre of the square upon a pedestal consisting of an architrave from a temple in the Forum, two colossal statues of Castor and Pollux standing beside their steeds, found in the Ghetto, were placed at the angles of the entrance, and the balustrade was further decorated with the so-called armorial trophies of Marius, really of the period of Domitian, that have become typical enrichments. The central façade is that of the Senator's Palace, ornamented with an applied order and having a beautiful double flight of steps, and the wing buildings were ultimately completed in accordance with Michelangelo's design.

The city was thus beginning to realise herself and look back with pride upon her ancient glories after nearly a century of revival of classical types in sculpture and architecture. Interest in the public squares and their adornment was quickened and ere long followed by a great movement for street improvement and practical town-planning.

To the period of the revival of the city under the Popes at the end of the sixteenth century are to be traced the sources of many of the ideas that have become the commonplaces of grandiose architecture. The civic architecture of the modern world is a combination of the revived classicism of the Eternal City with the practical and free mediævalism of commercial Europe; it is from Rome that the doctrines of a classical system of design permeated the Courts of France, Austria, and Spain, and, more tardily, of England, until they have completely dominated civilisation.

The city began to recover both from the plague and its brutal sack by the troops sent by the Emperor Charles V. ostensibly to protect the Pope, an incident paralleled by the Crusaders in Christian Constantinople, at the time when it was also becoming apparent that the issue of the Reformation had not deprived the Papacy of the allegiance of the whole Catholic world; the possession of the States of the Church was intact, and the decline of the North Italian cities tended to the benefit of Rome; the libraries, collections of antiquities and the marvellous works of art made it in a new and real sense the metropolis of intellectual culture.

The Later Renaissance Popes.

This later epoch of the Renaissance, extending from the close of Michelangelo's career until that of Christopher Wren, though neglected on account of the fantastic irresponsibility and the weakness of its architecture, gave birth to the art of improving and adapting irregular ancient cities—that is, to the study of town development and planning—the ideals that had rebuilt St. Peter's and evolved the Italian palace being applied to the complex problem of the city.

The vigorous characters, financial resources and architectural enthusiasm of four Popes effected the reconstitution of Rome as a progressive city, raising the population to 100,000 and giving the city its subsequent aspect and reputation.

Sixtus V., Felix Peretti Montalto (1585–89), completed the long-delayed Dome of St. Peter's, and with extraordinary activity and civic perception set to work in the city.

Paul V., Borghese (1605–21), builder of the celebrated family villa, employed Carlo Maderna to extend the nave of St. Peter's with the narthex and façade.

Urban VIII., Barberini (1623–44), fortified the Vatican Gardens and connected the palace with the Castle of S. Angelo.

Alexander VII., Chigi (1655–67), was the patron of the sculptor-architect Bernini.

Sixtus V. first realised the opportunities presented for the practice of street improvements with the zeal and autocratic temper necessary to business, and his successors followed his example, but he displayed also a true consciousness of amenity in describing the motives of his restoration of the water supply, called after him the "Acqua Felice," the ancient Roman aqueducts having for centuries been derelict. The Pope says: "That these hills, renowned for the salubrity of their air, the pleasantness of their situation, and the beauty of their prospect, might again become inhabited by man . . . therefore we have suffered ourselves to be alarmed by no difficulty and deterred by no cost." Paul V. followed this example by bringing water to the opposite side of the city, called the "Acqua Paolina," providing for the piazza of St. Peter's, and the sculptors and architects proceeded thereupon to indulge their rococo fancies in the many fountains that adorn the public places.

Great routes were planned by these Popes upon direct lines between the major basilicas upon the higher ground. These streets were finely conceived with terminal points and piazzas, those leading to Sa. Maria Maggiore and others culminating at the Piazza del Popolo, establishing a scale and type in street-planning that are

among the more important fruits of the Renaissance in civic architecture. The effect was novel, unknown alike in ancient Rome or in any mediæval city, of an architectural street on a considered plan and composed of elevations harmonious in character, though the idea of a continuous design had not yet developed.

The special problem at Rome of communication between the higher and lower levels of the city, already illustrated by the restored access to the Capitol under Michelangelo, was solved with remarkable architectural success by the flights of steps descending from La Trinita di Monti at the end of the great Via Sistina, to the Piazza di Spagna, a name significant of the dominant Spanish influence. A later notable solution is the fine roadway ascending by returns from the Piazza del Popolo to the gardens on the Pincio, laid out for Pius VII., after his journey to Paris to crown Napoleon, by Valadier.

The conflict of the new ideas with old conditions involved in the street improvements of the Popes appears in a report of the Venetian ambassador upon the works of Alexander VII. in 1661. "Many streets of the city," he writes, "have been rendered straight by the casting down of houses and palaces; the columns and other impediments that stood before the doors of individuals have been removed . . . the projections and signs of the shops have been restricted within due limits; all works which doubtless increase the beauty of the city, yet, as the weight of them falls on private purses, it cannot fail to excite many murmurs to see one's own nest thrown to the earth, and to be compelled to contribute large sums for the arrangement of streets which are of no advantage to those who thus pay for them, under the pretext that their dwellings will have a more agreeable appearance or enjoy a finer view."

All cities blessed with history and life illustrate the ruthlessness of the present in dealing with the past, between the insistent demands of public utility and the claims of sentiment presented in ancient buildings. The variety of human temperament between progress and conservatism is manifested in dealing with the remains of antiquity, and the progressive spirit sometimes becomes destructive upon slight excuse. Raphael's conservative influence over the remains of Imperial Rome succeeded to Bramante's reputation as the "Ruina," and for a time the interest in antique sculpture and architecture was maintained; but the zeal of Sixtus V. for the progress and glory of the city was unheeding of such sentiments in its fury. After much irreparable damage had been done, the cardinals were moved to implore from the Pope a respite in his determined clearance, which was to be radical and wholesale, of what he described as "these ugly antiquities." The vision of orderliness and improvement is so scarcely to be reconciled with ruin and useless obstruction; it is still a fundamental problem and trial to civic architects.

A new appreciation of ancient Roman civic ornaments became possible when Sixtus, possessed with the idea of symbolising the triumph of the Church over Paganism in concrete expression, raised and rededicated with Christian emblems columns, statues, and obelisks. The story is well known of the erection of the Egyptian obelisk that had once stood in the circus of Nero on the Vatican, but for centuries had laid prone behind St. Peter's. Domenico Fontana, the architect, with considerable inventive engineering skill, achieved its elevation and removal, and, crowned by a gilded cross, it was placed on the axis of the church before the remains of the ancient front, yet unrebuilt, and at a generous distance, a full generation before the great piazza was designed or laid out. Ancient and modern obelisks in Paris, London, and Washington have followed this unintellectual example of civic decoration, and civic architects seldom attach more purpose to their employment than the convenience of avoiding the difficult but urgent problem of descriptive and commemorative decoration and ornament. The Pope also transferred, by simple tailoring, the purpose of the triumphal columns of the Emperors Trajan and Marcus Aurelius to the honour of St. Peter and St. Paul through clothing the statues on their summits with apostolical appendages.

To Alexander VII. belongs the very considerable honour of accomplishing the laying out of the great atrium and piazza of St. Peter's, perhaps the most impressive and greatest single work of civic architecture in the modern world. The plan, carried out by Giovanni Lorenzo Bernini of Naples, but based on a design of Carlo Fontana touched with the freedom of a sculptor's originality, is novel both in form and treatment, and excels in grandeur even the scale and scope of the largest of the ancient forums. An inner piazza, or atrium proper, was formed, having for its base the extended narthex of the cathedral façade, about 400 ft. in length, the wings of which were crowned by Bernini with superstructures afterwards removed. The northern and southern sides of this forecourt

for a similar length were laid out on lines converging to a diminished distance of about 300 ft. It appears that if extended these enclosing lines meet at the entrance to the bridge and Castle of S. Angelo, more than half a mile distant. These great lines of vision are to be recognised in the Borgo Nuovo and the Borgo Vecchio; the elimination of the intervening blocks of building would present a scheme of approach of wonderful interest and reasonableness. This idea is the basis of the peculiar treatment of the flanks of the atrium which has so baffling an effect in actual perspective, increased by the less justifiable invention that the sides of this inner piazza, containing corridors and stairs, are built with bases and cornices on rising instead of horizontal lines in order to attain the level created by the great triple platform of steps that fills the square. The great piazza in front of the atrium proper is conceived as a complete elipse—a geometrical figure that was at this period a new and fashionable element in architectural design, and employed freely in the place of circles and their segments for domes as well as plan forms. Points already determined by the obelisk, placed upon the central axis of the church, and by the two great fountains on either hand, were skilfully used as foci in setting out the curved ends to the north and south, the sides being open on the west to the atrium and on the east to the outer piazza, now built across and called Piazzi Rusticucci. The internal long diameter of the great eliptical piazza is 600 ft., just half as much again as the short diameter.

The immense colonnades reared around the curves of the piazza are without parallel in civic architecture. The columns and piers number 350 and are 48 ft. in height, forming in four ranges a triple carriage approach to the corridors of the Vatican and St. Peter's; they have immense dignity from without, and the form of their plan offers a constantly changing picturesqueness of outlook. Besides their artistic motive they have the practical value of screening, after the manner of the porticoes of the streets of Roman cities, the irregular buildings of the pompous and inchoate Papal palace on the north and the plebeian suburb on the south.

This great work of civic architecture, though but partially executed, is significant on account of the skill with which an increasing scale is employed that does not suffer even from the exaggeration of St. Peter's itself, and by which is associated the grandest forecourt in the world with its greatest building. The whole purpose intended is accomplished of providing a beautiful approach and of supporting the building architecturally by a magnificent site treatment. The fame of the colonnades as well as of the converging streets probably incited Sir Christopher Wren both in his porticoes at Greenwich and in his plan for rebuilding London, his admiration for the genius of his elderly contemporary Bernini being, as he informs us, very great. The flanks of the front to the cathedral at Petrograd and subsequent smaller ventures attest the constant influence of the revived colonnade motive, and the development of the piazza with an undeciphered hieroglyphic obelisk as a pseudo-architectural centrepieçe was soon copied at the Place de la Concorde at Paris and in other public places of capital cities.

Piranesi.

Reference has been made to the want of appreciation and contempt for the imperial ruins with which the city abounded, and to the real difficulty of combining them in schemes; but in the succeeding century their impressive degradation seized the genius of Piranesi, an architect who published books of etchings described as "The Magnificence of Rome" and as "the most remarkable antiquities." These drawings with imaginative power display, not only the ancient, but the then modern aspects of Rome. Piranesi proceeded, urged by the instinct of a born architect, to publish designs that are vast architectural compositions mainly of a civic character. These designs are well calculated to inspire enthusiasm for a civic architecture such as the world has not yet seen in buildings of a poetic scale of immensity, and these visions have not been without effect and value in concrete building and civic art. Their source was the sense of the glory of ancient Rome mingled with the magnificent fashion of the modern era, to which the improvements which culminated in the completion of St. Peter's and its piazza belonged. Thus the wonderful Rome of Piranesi's citizenship expanded and glowed with apocalyptic splendour in his architectural visions. Civic improvement may be merely utilitarian, but its vitalisation by an architectural idea is not only a desirable corollary, but is a necessary expression of the fact that man is more than a locomotive and that civilisation implies intellectual progress. To this end the stimulus of a vision is essential: the Renaissance is the birth and growth of this sense of an artistic aim superimposed upon life, the mediæval native fire having become extinct. Piranesi, with his vivid sense of architectural magnifi-

cence, may be regarded as summing up and expressing in his drawings this idea, both in ancient and modern Rome, in its romantic and living actualities; he concentrates the Renaissance, which began with the painters and sculptors of Tuscany, and moved from building to building into a noble architectural style upon the whole city in its greatest aspects, full of the spirit both of the Empire and of the Papacy. His works are a source, like the Acqua Felice, of fruitful life to the civic ideal, and he remains unrivalled in any review of the history of civic architecture, more potent in influence and stimulus than even the greatest of the town builders. With the publication of Piranesi's works Italian leadership passes abroad. Paris erelong sought and obtained a measure of her own ideal, and it remains possible that even the greatest city that the world has yet seen, taking to heart her own needs, may, without waiting for another Piranesi or Christopher Wren, find the stimulus of a vision to illuminate the solution of her progressive needs.

Renaissance Gardens.

The great gardens of the Italian villas, as well as the compact plans of those of the palace enclosures within the cities, exhibit in a remarkable manner the revival of the Roman sense of an expansive and all-embracing magnificence. The later Renaissance garden is a concomitant of many wonders: if the mediæval world had failed in its appreciation of natural beauty, the succeeding epoch undertook the association of nature with art by mingling sculpture and architectural features with gardens and vegetation by means of a novel system of planning that was essentially geometrical. Axial vistas of almost indefinite length and perspective effects, natural or artificial, characterise almost every example, with ingenious adaptations of hill-sides and of varying levels by the artistic use of flights of steps and terraces; fountains, cascades, grottoes, and musical caverns occur as elements of wonder in obtaining beauty with mechanical artifice. Nature, art, and the science of the day all serve the splendour of gardens in this period. The progress from an enclosed garden of an intra-mural palace to the ornamented public square, and from a great paradise to the civic park, is easily discerned, and new possibilities develop and are yet unexhausted. The combination of the noblest public buildings ancient or modern with gardens and tree planting originating in Italy, developed in the aristocratic domains of France throughout the eighteenth century, and then invaded the public places and thoroughfares; it has become in a democratic world a proper popular ideal demanding the guidance afforded by inspired study of the subject.

Examples in Europe.

The city of Turin may be instanced as an important example of an ancient historic Roman plan developed by the employment of a background of natural features to a civic extension conceived on lines of great magnificence. The realised value of a fine building or scene as a termination to a vista led to the enlargement of the width of the street or avenue containing it—of this Turin is an illustration. Thus an effect, in itself merely architectural, dominates fundamentally a multitude of other interests and factors in the city plan; the artistic end when sufficient in itself triumphing over all other considerations. Grandeur of this order found much favour in France, and Versailles did not exhaust its possibilities for it underlies the Champs Elyseés. Examples can be supplied from many minor European capitals, while in England the schemes of Sir Christopher Wren for Hampton Court and for the Palace of Winchester as well as indications in his plan for London, and the very considerable scenic achievement of the Palace at Greenwich, show that he was seized with the idea of expansive classical planning, combining architecture with ordered landscape.

The academic design of towns steadily became a branch of recognised architecture, though the opportunities for its exercise were few; ingenious artists experimented on paper, and an occasional magnate ventured into building. Richelieu is a small town, planned and entirely built by the great Cardinal who bore its name, and who had a small ancestral connection with the district. It is an exercise in the theoretical geometry of a town plan, with a central avenue leading to the square of the chateau. The scheme proved a practical failure early in its history: the town had no other object to fulfil than the founder's glory, who had neglected to consider its marshy surroundings and unsuitability for trade. A more ambitious experiment in diagrammatic planning is Carlsruhe, built by the Margrave of Baden, Charles William, in 1715. Here the town is but an appendage to the idea of the lord's hunting seat and park, and its name, "Charles's Rest," indicates the personal whim of the founder. The scheme is a circle, three quadrants of which contain the

palace and grounds, the buildings of the palace very ingeniously occupying the centre and flanks of the quadrant that opens on to the town and screening the sacred park from the populace. Theory or architectural fancy construct these puzzle plans, but their impression is singularly uninteresting and lifeless.

The additions to the ancient town of Nancy that were laid out in the middle of the eighteenth century by Stanislas Leczynski, ruler of Lorraine, have an architectural character that has made this town a typical favourite with town-planning students. A noble quarter—dignified but without exaggeration, formal and spectacular yet entirely practical—was added to the old city; its fame is entirely justified by the plan that has gained ultimate success through its expression in a charming phase of the French Renaissance, and besides its entirely adequate architecture, the grilles, gates, and tree-planting of the public squares complete a scheme of accessories to the buildings that is typical of the justness of French taste at this period. Later in the century Bath supplied an English example of development in the classic manner around an ancient centre; but as at Nancy the problem was a partial one, dealing practically with but a single aspect of the town—at Bath the better-class residences and streets for the fashionable world, and at Nancy the Royal and public buildings.

The classical system of architectural design prevailed throughout Europe during the eighteenth century, derived from Rome through the powerful influence of Paris and the French monarchy. A dignified ordinance subdues all the house fronts into a fine street elevation, suppressing individuality and imposing cornices as limits of height and the spacing of pilasters for widths and windows. Quarters of cities were composed of similar streets and squares, including residential and commercial purposes in the same architectural *régime*.

England in the Nineteenth Century.

England has its special phenomenon in London, one that requires, on account of its overwhelming size, separate consideration. Of the rest there remained at the beginning of the last century much of that steady, traditional growth of country towns along the high roads that seems natural, together with evidences of the presence of the enlightened scholarly ideal of the classic student who had travelled for the purposes of architecture in France and Italy. Edinburgh and Buxton illustrate in our smaller measure the movement which flourished for a whole century previously on the Continent; the classically-schemed streets, squares, terraces, quadrants, crescents and circuses by which the residential quarters were advanced entirely proved their worth as factors in the town-planning of residential areas, until the Gothic craze for picturesque detachment upset the mental balance and turned regularity and squareness into bywords. The new Edinburgh of the brothers Adam, of the first part of the century, was and remains a highly satisfactory performance, and its classic note has supervened in a city retaining consciousness of its mediæval history and character. Newcastle, a little later, derived from Grainger's work dignified streets and well-planned improvements. Brighton and St. Leonards may be cited as still illustrating the architectural side of residential-quarter planning, partial though extensive, but not comprehending the elements of a town. The expansion of industry following upon the Great War, accompanied by the application of steam to locomotion and the railway fever, outran the artistic resource of the nation with disastrous consequences, in the unrestricted situation of factories and the non-provision of districts for working-class dwellings, producing a degradation both in the ancient and modern quarters of towns that has effected irreparable harm to the age.

The municipal expansion that followed the Reform Act was not authoritatively founded on responsible ideas of civic order either in building practice or economic development. The nation was in a hurry to govern itself in detail, was too excited by the possession of electoral power and absorbed in the ridiculous application of the party system to municipal life, to care about the essential government of its towns, new or old. The expansion of England went on with a measure of glorious freedom from carefulness that may generally be described as shortsighted and selfish.

It is a much longer process to awaken the conscience and instruct a preoccupied but self-governing people in the higher interests of a community than to direct them authoritatively from a central government, and it is taking a long time in England. The last three quarters of the nineteenth century ran their full course of development without any perception by communities in detail, or the nation as a whole, that many of the evident evils of factory labour and ensuing insanitary conditions should be attacked at the root instead of in the fruit, or

that the want of a comprehensive ideal in a town plan is a defect in civic existence like the lack of moral principle in conduct. The manifested evil has produced the housing and town-planning movement of this century as a preventive, not as a curative measure; internal reconstruction and improvement on any comprehensive scale such as Haussmann administered in Paris is as yet unknown in these islands. The material is abundant, and there can be no real doubt that the capital required for such a certain economic increase is available. What could not be done, for instance, with Dublin, where so many noble buildings, interesting sites and surroundings, and a beautiful river and port are waiting for co-ordination? Liverpool, Manchester, and Leeds, and other great cities, rise to self-conscious dignity in their municipal buildings and in some of their streets, but the prophecy may be made that if their eyes could be opened to see the golden opportunities that lie in their inchoate and unregulated plans of achieving municipal glory, social health, a revived civic architecture of amenity and delight, together with an assured return in rateable value, there would be little hesitation in urgently attacking the difficult and involved, but splendidly remunerative, work of drastic and comprehensive town-planning.

(*To be continued.*)

THE ZINC MINES OF TONKIN.

Zinc is the leading metal produced in French Indo-China. During the past five years the exportation of zinc ore from Haiphong has averaged nearly 27,000 tons per annum. The customs value of this ore during this period has averaged about £128,000 per year, but the market value has been considerably higher.

Although some zinc has been mined in Annam, and this mineral undoubtedly exists in the interior Protectorate of Laos, practically all of that now produced in French Indo-China comes from the Protectorate of Tonkin, and is exported from the port of Haiphong. The zinc mines exploited at present occupy a strip about 50 miles wide and 100 miles long just above the delta district, a little north and a little east of the centre of the protectorate. There are four well-defined zinc regions.

According to a report by the United States Consul at Saigon, the oldest zinc region of Tonkin is the Tuyen-Quang district, near the town of the same name at the junction of the Clear and Gam rivers. The ore from this group is carried in river steamers down the rivers and through the canals to Haiphong.

Next in age, and in recent years the most productive district, is the Thai-Nguyen region, above the town of this name on the Song Cau, about 50 miles east of Tuyen-Quang. This is the most extensive district, and is located near the centre of the Tonkin zinc fields as they are at present exploited. The ore from these mines is floated in sampans down to Dap Cau, nearly 100 miles, then transferred to river steamers.

On the extreme east is the Than-Moi or Langsor region, on the upper waters of the Song Thuong, and along the railway between Phu-lang-thuong and Langsor. The ore from this region is transported by rail to Phu-lang-thuong, where it is loaded on river steamers.

The newest and perhaps the richest of these regions is the Cho-dien or Bac-kan district, east of the Song Gam, about 50 miles above Tuyen-Quang. The ore from the Cho-dien mines is carried by a private railway to the Song Gam, then by sampans to Tuyen-Quang, whence it is transferred to river steamers.

These four regions include about thirty zinc concessions, of which only eleven are at present in process of exploitation.

Although the Chinese are known to have obtained zinc from Tonkin before the French occupation, the serious exploitation of this mineral dates from 1906. In this year some coolies working on the estate of Commandant Cadars at Trang-da, opposite Tuyen-Quang, discovered a vein of zinc ore. Further search proved the mountain to be rich in this mineral. Lacking the necessary capital and experience, M. Cadars formed the Société des Mines de Trang-da, with a capital of 300,000 francs (£12,000), and with its headquarters at Tuyen-Quang (later changed to 35, Rue de Clichy, Paris), for the exploitation of the first zinc mine of Tonkin. The first year this mine produced about 2,500 tons of ore. In 1909 the production had reached 8,000 tons, and since that date the annual output of this mine has remained at about 10,000 tons.

The discovery of zinc at Trang-da led to the exploitation of the old Chinese mines at Lang-hit, near Thai-Nguyen. Several mines were developed, and in 1909 M. Marcel Pierron, backed by the German firm of Speidel and Co., formed the Société Minière du Tonkin, with a capital of 1,000,000 francs (£40,000), with its main office at Haiphong (later transferred to 14, Rue Vézélay, Paris). At that time these mines produced only a few thousand tons of calamine and blende, but in 1911 their production reached 14,432 tons, and they have since held first rank among the zinc mines of Tonkin.

In 1909 also the Société Minière de Than-moi was formed at Paris (14, Rue Vézélay) by M. Marcel Pierron, who retained 80 per cent. of the stock. Its mines are located on the Song-Thuong, between Phu-lang-thuong and Langson. The production of these mines has been irregular,

varying from 492 tons in 1911 to 5,368 tons in 1914, but the ore is of a high grade.

In the meantime M. Cadars and others discovered three other veins near Trang-da-Kem, Con-rau, and Con-rong, and in 1910 they organised for their exploitation the Société des Mines de Yenlink, a joint-stock company with a capital of 700,000 francs (£28,000), and with its headquarters at Tuyen-Quang. The output of this group during the first four years averaged only about 1,100 tons per year; but in 1915 its production was about 3,000 tons, and in 1916 about 4,000 or 5,000 tons.

Several other concessions have been taken up in the Tuyen-Quang region; but the only other mine that has been sufficiently productive to deserve mention is that of Bac-nhung, belonging to Perrin Frères, which in 1914 produced about 450 tons of ore.

The grade, and sometimes the character, of the zinc ores of Tonkin vary with the different mines, and even in the same mine. The most common ores are blende and calamine (zinc sulphide and silica hydrate). These ores range from 40 to 55 per cent. metallic zinc. Each of the mines has a reducing plant where the ores are crushed, washed and calcinated, and thus reduced to 55–80 per cent. pure zinc. This finely crushed ore is then put up in gunny sacks for shipment and sent to Haiphong, from whence it is transhipped to Europe, and recently to Japan and America. The following table shows the character and grade of ore produced by each of these mines in 1914, and the average market price in francs per metric ton of the product delivered at Haiphong:—

Mine.	Character of Ore.	Metallic Zinc.	Market Price.
		Per cent.	Francs.
Trang-da	Calamine	40	60·60
Kem	,,	45	122·88
Bac-nhung	,,	52	132·22
Lang-hit	,, and blende	50	115·00
Van-lang	,, blende and galena	45	64·05
Than-moi	,, and blende	56	131·93
Cho-dien	,,	50	115·01

The Van-lang mines in the Thai-Nguyen group began production in 1911, although the concession was not granted until the next year. It is operated by the Société d'Exploitation des Mines de Van-lang, Hanoi. The production of this mine for the years 1912 to 1914, inclusive, was respectively 1,800, 1,500, and 1,672 tons of blende, calamine, and galena. The ore is of low grade, and the mine ceased operations after the outbreak of war.

The Cho-dien concessions were granted in 1912, but, because of the inaccessibility of the mines, actual exploitation did not begin until 1914. Here the proprietor, M. G. Bault, Hanoi, was obliged to build a railway of 35 kilometres (about 22 miles) from the mines to the Song Gam at a cost of nearly a million piastres. This railway was not completed until July, 1914. During that year about 1,900 tons were produced. During 1915 the production of these mines reached 8,600 tons. At present the Cho-dien mines are surpassing all others, and a yield of 15,000 tons was expected for 1916. The ore is mined in the open from the side of a hill, and it is said that 80,000 tons of 52 per cent. ore presents itself to view. This seems to be the future zinc field of Tonkin.

Up to the present the zinc ores exploited in Tonkin have been found near the surface. Outcroppings on the hillsides have been exploited in the open air, or followed by means of horizontal tunnels. The principal tools used in the mines are pickaxes, shovels, and Decauville cars. The reducing plants make use of the best modern machinery, and are generally operated by electric power generated by steam. Electric drills and dynamite sometimes assist the labourer in following up a rich vein; but on the whole mining machinery is seldom used. This has been due to the quantities of ore near the surface, the abundance and cheapness of native hand labour, the difficulty of obtaining European skilled workmen, and lack of capital. But modern mining machinery must ultimately come to Tonkin. This is a part of the problem of the future development of these mines.

The exportation of zinc from the port of Haiphong (in metric tons) is given on p. 712.

The chief drawback of the economic system of French Indo-China has been the lack of a loan and discount bank which could advance money to a worthy enterprise. The consequences have been that many of the firms formed to exploit the mines were backed by foreign capitalists, who held stock in these firms, advanced them money, and carried their product to the refineries

Port of Destination.	1913.	1914.	1915.
Dunkirk	12,936	4,991	—
Havre	—	—	500
Marseilles	—	—	17,403
Antwerp	13,766	14,571	—
Hamburg	1,021	—	—
Hong-Kong	9	—	518
Japan	—	—	7,089
United States	—	—	7,825
Total	27,732	19,562	33,335

of Hamburg and Belgium. At the outbreak of the war these firms are said to have had long-term contracts for the products of the Tonkin mines.

The immediate effect of the war was the breaking off of all business relations between French operators and German financiers, the withdrawal of German capital, and the loss of a market for Tonkin zinc. The ore already in the hands of these foreign firms was tied up, and further production was precarious. Tonnage was lacking for the zinc available for exportation. In December, 1914, some of the leading zinc producers of Tonkin were seeking a market for their product on almost any terms.

But the situation soon began to clear up. German goods in French Indo-China were sequestrated in November, 1914. The decree forbidding the exportation of zinc was put into effect in Indo-China early in 1915. The belligerent nations had become convinced that the war was not a matter of a few months, and the consequent demand for metal was unprecedented. As a result the price of zinc began to mount, until on July 1st, 1915, zinc ore at Haiphong was worth two or three times as much as on July 1st, 1914.

With the rise in the price of zinc, and with the demand for this product made by the Allies and the neutral nations, the zinc mines began to resume operations. The smaller companies found themselves confronted by two serious handicaps: (1) The lack of sufficient financial backing, and (2) the mobilization of European operators and employees. As a consequence, although production in 1915 was greater than in any previous year, the product came entirely from a few of the larger firms.

During the early part of 1915 most of the exported zinc went to France; but the export restrictions were moderated, and later in the year a good share of this ore went to Japan and the United States. Between October 1st, 1915, and February 1st, 1916, the Société Minière du Tonkin exported 9,325 tons of ore to Baltimore and 1,300 tons to Galveston *vià* Marseilles—the first Tonkin zinc to be shipped direct to the United States. Most of the product of the Lang-hit mines is still finding a market at Baltimore, while it is understood that a Japanese firm has made contracts for the output of the mines of Tuyen-Quang.

Under the stimulus of unheard-of prices, the larger zinc mines of Tonkin have been running at their utmost capacity, limited only by the difficulty and expense of installing new machinery and the practical impossibility of maintaining an efficient staff of European operators and overseers. In all the zinc fields a greatly increased production is expected, the total output for 1916 being reckoned at 50,000 tons.

The zinc-mining operations of Tonkin up to the present have been merely scratching the surface of the rich and extensive fields. The preliminary surveys of the country have marked on the maps the places where zinc is known to exist without much knowledge of the extent of the deposits.

The great needs of this industry are machinery, operating capital, and transportation facilities. Under the present conditions it is only profitable to exploit the richest ores near the surface of the easily accessible mines. Operating capital and improved methods of internal transportation would greatly enlarge the available fields, while modern machinery would enable the present mines to be worked at lower levels and would make it possible to extract the mineral from the lower grades of ore now thrown away. The question of establishing a central refining plant at Haiphong or some other place in Tonkin is being considered, and has so many obvious advantages that it is sure to come.

ENGINEERING NOTES.

Tilting Crucible Furnace.—The *Daily Telegraph* says, for melting cartridge-metal and pouring it into strips for rolling, the latest development is a gas-heated tilting crucible furnace, in which the trunnions upon which the furnace-body turns are in line with the lip of the crucible. This is of 600 lb. (brass) capacity, so that as the furnace-body is tilted the pouring-point is practically constant. By means of a turntable, or by a trolley running on rails in front of the furnace, moulds sufficient to take the whole contents of the crucible can be brought successively under the pouring-point, and the crucible emptied with maximum rapidity. The furnace is tilted by means of chains attached to the front of the base of the furnace-body and passing over sprocket wheels controlled by hand-gear to a counter-balance weight in the rear. When the furnace-body is down on the base-plate and the crucible charged before melting, a pre-heater is swung over it and lowered upon the top of the

casing; a sleeve in this pre-heater corresponds with the opening of the crucible, and serves to extend it so that more ingots can be added to complete the charge. When it is required to pour the metal, the pre-heater is lifted clear of the furnace-body and swung out of the way.

Papuan Oil-fields.—The Federal Government of Australia is inclined to consider what action is necessary to extract from the island of Papua the mineral wealth and oil which it has been proved to contain. For over two years a party of experts, under the direction of Dr. Wade, had been experimenting, and each successive bore sunk has struck oil of good quality. The Minister of Home Affairs and Territories has stated that something ought to be done to turn the mineral resources of the island to profit, and if the necessary plant was on the field and oil could be drawn off in large quantities, the benefit to the Commonwealth and the Empire would be enormous.

A New Triangulation Signal Lamp, etc.—The above subject has been treated in *Science* by E. G. Fischer in the following terms. Though the general principle employed in geodetic surveys is the same as in the survey of a railway, a farm, etc., the great distance between the points, varying between 10 and 100 miles, or over, requires not only the use of specially large and refined instruments, but also a special means of making the point visible to the observer. This is now done in daytime by reflecting sunlight to the observer from a mirror placed accurately over the point, and at night by means of a specially constructed acetylene lamp. Distances of the magnitude mentioned can be penetrated by either means under favourable weather conditions, and many days during a season are lost when the atmosphere is only slightly clouded by smoke, fog, etc. The storage cell was studied by the United States Coast and Geodetic Survey with the view of using electricity as a source of light. Its cost and weight, and the difficulties connected with its maintenance, were found too great. Electric generators, with the necessary prime mover, were found to be too heavy for transporting to difficult stations. The result of a series of tests of dry cells, which are readily divisible into loads suitable for climbing difficult ascents, however, warranted the design and construction of a new type of lamp, the use of which will increase the number of observing nights per month by at least 25 per cent. The main part, an ordinary automobile head-light, is suitably mounted for directing in horizontal and vertical planes; the lamp is provided with an ammeter, rheostat, and a switch. The whole, packed in a strong case, weighs 23½ lb. In order to obtain most nearly the maximum intensity of the light, it was necessary that the lamp should be provided with a filament concentrated to a degree not found in those on the market. A lamp manufacturer was induced to make the necessary designs and experimental tests, and submitted a number for trial. The use of the dry cell was found practicable, and not too costly, on the assumption that the proposed lamp was not kept burning throughout the night. The trial of the newly-designed lamp, by comparison with the present acetylene lamps, however, proved the former so much superior that it was decided to have the light shown only for the few minutes each time it is observed upon. This reduces very materially the consumption of current and battery cost. The lamp, after being provided with two additional bulbs, one for medium and one for short distances, was tested by the Bureau of Standards, and found satisfactory in all respects. In partial reference to the above we extract from other sources the following information. Observations have just been completed by the United States Coast and Geodetic Survey on an arc of primary triangulation 630 miles long from Northern Utah to North-eastern Oregon and thence to Portland. For the first time in this class of work the surveying party was transported by motor-truck, and as a result of this experience all parties engaged on similar work are to be provided with this means of transportation. The truck carried the party to the bases of the peaks from which observations were made, the equipage and instruments being transported to the top by horses or members of the party. Most of the observations were made by night, with acetylene lamps for sights. Observations were made from end to end of one line 134 miles long in this way. The elevations of a large number of mountain peaks were determined accurately by triangulation for the first time by this survey.

Mid-Scotland Ship Canal.—The question of this canal has long been under consideration by committees in the Glasgow and Edinburgh districts, and representations have already been made to the Government on the matter. Two routes have been mooted, one *via* Loch Lomond, and the other direct from Clydebank to Grangemouth. A report on the latter was recently considered by the committee. It is proposed therein to construct a sea-level canal with two locks, one at either end. The width of the canal at the bottom would be 148 ft., and the depth 40 ft. throughout. The direct route would be 30·5, and the Loch Lomond route 85·5 miles in length. With this report, presented by Messrs. Crouch and Hogg, of Glasgow, was also submitted an ordnance survey map of the route. The direct route could easily be lighted, and therefore utilised by day and night. The report with the map was forwarded to the Admiralty. Some years ago it was estimated that the direct route would cost £25,000,000, and the cost under present conditions would naturally be much greater. It has also been estimated that the annual revenue from mercantile craft would be £1,000,000 at least. At a meeting of the Glasgow and West of Scotland branch of the Navy League, the "Direct Route" was emphatically recommended.

NOTES ON BOOKS.

THE PICTURE RAMAYANA. Compiled and illustrated by the Chief of Aundh. Bombay: 1916.

This book consists of a long series of drawings by a well-known native artist, illustrating the principal incidents in the great Indian epic, the "Ramayana." To the Hindus—and for that matter, to many Muhammadans and even Europeans—the "Ramayana" is a household word. Every Hindu child knows its chief features by heart, and it has been a good idea that a Hindu of learning, who is also a draughtsman of some skill, should publish his ideas on the many scenes occurring therein, to let the world—especially the European world—know how Hindus picture these scenes to themselves.

They have, of course, been illustrated in many a drawing and sculpture from all time, but in what may be called the ancient and mediæval style, in which perspective and proportion are conspicuous by their absence; and so the European, unless he be a special student, has not much benefited by what has been presented to him. But of late years the native Indian has mastered these essential points in draughtsmanship, and is now producing many illustrations, in a generally intelligible style, of the literary scenes with which he has been familiar from his childhood, to the great benefit of all who care to study his literature. Purushotam Mauji's "Cloud Messenger" is a case in point, in which M. V. Durandhar's admirable illustrations forcibly bring before us from the native point of view the scenes in Kulidasa's immortal poem of the "Meghaduta." As in the case of the "Picture Ramayana," each illustration in the "Cloud Messenger" is accompanied by a short description in English.

The Chief of Aundh has been fortunate in securing a foreword from the pen of no less a personage than Lord Sydenham, formerly Governor of Bombay, and a preface from so competent an authority on things Indian as Mr. C. A. Kincaid. With the help of these and his own drawings, the Chief has been able to place before the European student a valuable work, and I for one congratulate him on his efforts to make the foreigner in the land catch something of the spirit of the great native epic. R. C. TEMPLE.

GENERAL NOTES.

OWEN JONES COMPETITION.—The Exhibition of Designs and Works sent in for the Owen Jones Prizes, which was held at the Victoria and Albert Museum, was closed on August 25th. Owing to special circumstances it was impossible to throw the exhibition open to general visitors to the Museum, so that all those who visited it had special reasons for doing so. The total number of visitors was 958. They were nearly all teachers and students from schools of art, many of whom were connected with schools which have not taken part in the competition. Some of these expressed their intention of competing next year. The general impression gained from the visitors was that the collection was very interesting and showed much promise. The arrangements for next year's competition will be published a little later on.

THE INSTITUTE OF METALS.—The annual Autumn Meeting of the Institute of Metals will be held on Wednesday, September 19th, in the rooms of the Chemical Society, Burlington House, Piccadilly. The opening session will be between the hours of 4 p.m. and 6.30 p.m., the evening session from 8 p.m. to 10 p.m. Invitations to be present at the meeting can be obtained by non-members of the Institute of Metals on application being made to Mr. G. Shaw Scott, M.Sc., Secretary, 36, Victoria Street, S.W. (1)

GOTHA AEROPLANES.—According to *The Army and Navy Gazette*, the Gotha biplanes are about 40 feet in length, and of the "pusher" type. The wings are nearly always equal in span (about 77 feet) with projecting ailerons, and are at a very slight dihedral angle. The gunners, both front and rear, can fire downwards and upwards, as well as on their own level, or right and left, and the bottom of the fusilage is open for a great portion of its length, which enables the gunner to fire at a pursuer either over the top of the fusilage or through the tunnel formed by it, and both gunners can also fire downwards through trap-doors. The aeroplane carries a crew of three, and the armament consists of three machine-guns. It cannot be approached from any direction without the adversary coming under the fire of one or other of these guns. In fact, the adversary who attacks the biplane from the rear is likely to meet the concentrated fire of two machine-guns. The first gunner sits nearly in the centre line of the machine, but the pilot is placed on the left, there being thus a passage on the right enabling the gunner in front to move to the back and work the second of the guns in the rear.

MADAGASCAR GRAPHITE.—Up to the year 1913 the bulk of the flake graphite of the world came from Ceylon, the output from that island being from thirty to forty thousand tons per annum. In 1907 Madagascar produced eight tons of flake graphite, and slowly increased the output until 1911, when it reached 1,246 tons. In 1913 the yield had gone up 6,313 tons; in 1915 to 11,851 tons, and in 1916 to 25,489 tons. The graphite, says the *South African Mining Journal*, is found plentifully distributed over the crystalline schists of the island, and as these occupy an area of over 200,000 square miles, some idea of the amount may be imagined.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

EXAMINATIONS.

The Programme of the Society's examinations for the coming year is now ready, and copies are being sent to the examination centres throughout the United Kingdom. (These now number nearly 500.)

The Programme contains the regulations, the time-table, syllabuses for all subjects, the papers set in May, 1917, together with the examiners' reports on the work done, and a summary of the results.

Copies may be obtained on application to the Secretary, price 4*d.*, post free 6*d.*

The examinations are arranged under the following stages: Stage I. — Elementary; Stage II.—Intermediate; Stage III.—Advanced.

In 1918 two examinations will be held in all three Stages, except in the County of London, where Stages II. and III. will be held in May only. The first will commence on March 18th and the second on May 6th.

In the Advanced and Intermediate Stages First and Second-class Certificates will be granted in each subject.

In the Elementary Stage certificates will be given in each of the subjects enumerated. These will be of one class only.

Certificates of proficiency in Commercial knowledge will be granted in each stage to candidates who pass in certain specified subjects during a given period.

In Rudiments of Music Higher and Elementary Certificates will be given; in Harmony Higher, Intermediate, and Elementary Certificates.

A fee of 3*s.* 6*d.* will be required by the Society from each candidate in each subject in the Advanced Stage, and 3*s.* in the Intermediate; in the Elementary Stage a fee of 2*s.* 6*d.* for one subject, and 1*s.* 6*d.* for each additional subject taken up by the same candidate. The fees for Harmony and Rudiments of Music are the same as for Stage II.

Medals (the cost of which is defrayed from a fund provided by the Clothworkers' Company) are offered in each subject in Stages II. and III. Full particulars will be found in the Programme.

Viva Voce Examinations are also held in French, German, Spanish, Portuguese, and Italian. For information as to these examinations reference should be made to the Programme.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

CIVIC ARCHITECTURE AND TOWN-PLANNING.*

By Professor Beresford Pite, F.R.I.B.A.

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Lecture III.—Delivered February 12th, 1917.

(Continued from page 710.)

PARIS.

The primacy of Rome passed to Paris during the eighteenth century, for in the nineteenth no city so completely represented and summarised the history and ideals of the epoch, or exercised so powerful an influence on civic architecture. At the outset of the century the Revolution, which was spending itself in the Napoleonic Wars, had dispossessed the Church of its extensive enclosed properties within the city walls, and sites became available for public buildings and improvements. The mediæval city succeeded the Gallic Lutetia on the original group of islands; it consisted of the two principal isles—those of La Cité and St. Louis—with the suburb of the left bank,

* The course consisted of four lectures, delivered on January 29th, February 5th, 12th, and 19th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into six parts.

and existed in characteristic compression and crookedness. The extension on the right bank that grew up between the Louvre and the Bastille spread towards the north and west with rapidity. These three main divisions of the isles, and the right and left banks, shared the public buildings between them without scheme or connection. Upon the island in the centre was the Palais de Justice, the former Royal Palace and the Cathedral of Notre Dame, the Episcopal Palace, and Hôtel Dieu. On the left bank, which contained rising ground, was the University (the Latin Quarter), most famous in the Middle Ages, when it occupied part of the island, though waning in influence from the Reformation period, the aristocratic quarter, the Hôtel Cluny, the ruins of the Roman baths, the École des Beaux Arts, the Mint, and the great churches of St. Germain-des-Prés, St. Etienne du Mars and St. Sulpice; beyond the mediæval limits Catherine de Medicis had built the Luxembourg Palace, and the whole was enclosed roughly in a semi-circle having the river for its base with its centre in the island. The right bank, which was generally flat with an extent of marsh land to the east, contained the Hôtel de Ville, the Royal Castle of the Louvre, the neighbouring Palace of the Tuileries, and, among many fine churches, St. Eustache, St. Germain de l'Auxerrois, the markets, and a tangle of lanes between the enclosures of the great houses of the wealthy class, extending to the site of the fortress of the Bastille, destroyed in 1789, at the eastern limit. As with all mediæval cities, the necessity of enclosing military walls had produced a multitude of internal evils, compensated only by the sense of security.

Philip Augustus (1180–1223), the first of the kings who made Paris in a real sense into a capital, constructed a complete wall enclosing the area on both banks, the larger being that on the left. During the reign of Charles V. (1364–80), the Provost Etienne Marcel erected the wall of a greatly extended area on the north bank, which included the Castle of the Louvre and necessitated the erection of a new external point of royal observation at the Bastille. Francis I. (1515–47) was compelled again to extend this area with a larger radius, but the circumvallation was not completed until the time of Richelieu under Louis XIII. (1610–43). With the exception of the fine twelfth-century wall of the right bank, the lines of these bulwarks remain clearly marked in the boulevards—their verbal equivalent—and the concentric extension of these lines is the basis of that zone system of circular roads for which we in London sigh in vain.

But underneath the city, and through its centre, lay all the while the great cross road, the main Roman way from Orleans to the North-east, crossing the Seine at the centre of the island and creating the haven and port to the fundamental circumstance of which the city seal of a ship still witnesses. Through all the periods of the city the great route has maintained its character and directness, and it has co-ordinated the subsequent development at right angles of the later growth, right and left, of the great road from the Champs Elysées through the Rue de Rivoli and Rue St. Antoine to the Place de la Bastille.

The Italian taste of the kings of the sixteenth and seventeenth centuries produced not only buildings in the city of great beauty, but provided public squares and gardens that were a new contribution to civic art. These squares, derived in idea from the Italian cortiles, were surrounded by houses of uniform elevation, and introduced the system of co-operative effect that has since become the commonplace of street architecture.

The internal peace imposed upon France by the military power of Louis enabled the very original and perhaps dubious project to be considered of dispensing with the system of fortification completed by Richelieu, and of employing the site of the walls and moat for a great surrounding bulwark roadway. The architects Bullet and Blondel prepared a complete plan of the new ring to which every street having hitherto a dead end opened—a new and healthful experience in town-planning. Beautiful arches were designed at the main roads, the Porte St. Denis marking the main cross-road, now appropriately faced by the terminus of the railway to the east. That an enclosing wall was erected outside this new grand boulevard and not intended to have military value, is an interesting fact indicating the hold that a primitive idea retained. A literal tariff wall was erected significantly a few years before the Revolution by Louis XVI., and this eventually became the outer boulevard of Haussmann. We do not stay to describe the development of the art of planning sites as evidenced in the palaces and institutions of the great French period of the early eighteenth century. The Luxembourg Palace, the Invalides, the École Militaire, the Tuileries with the Champs Elysées Avenue and Rond Point, the development of

the Cours de la Reine on the river bank, all illustrate the rapid appreciation of the possibilities of planned effect. The development at Fontainebleau and the regal scheme at Versailles were generating an art which was not yet thought of as free to the vulgar gaze; the city in its vital centre was still a hopeless and shameful mediæval mess; the contrast will afford sufficient justification for the Social Revolution, and serves to indicate the slowly-acquired wisdom contained in the title of the Housing and Town Planning Act. The visions of the architects were, however, extending to the conception of axial lines in Paris itself. Bullet and Blondel designed an ornamental place in front of the Tuileries garden laid out by the celebrated gardener Le Notre and connected to the site of the avenue of the Champs Elysées.

The great scheme of the Place Louis XV., now the Place de la Concorde, by the architect Gabriel, followed, and was completed about 1763. This was and remains the culmination of the art of stateliness in public places, rivalling the Piazza del Popolo in Rome in scheme, and like it furnishing not a centre but a head to the extended city plan. Mr. Edward R. Smith, of the Columbia University, boldly asserts that the beautiful plan of Paris as we know it to-day was actually conceived by the architects of the seventeenth and eighteenth centuries, and that the vast activities of the nineteenth century were controlled by a loyal regard for the principles then established. The great city builders, Louis XIV., his minister Colbert, Le Notre the gardener, Blondel and the Academy of Architecture, left the mark of their ideals firmly impressed upon the inheritance of the Revolution against the system that they represented, which left its internal condition in the hideous contrast that Voltaire described as barbaric and disgusting. The sense of civic existence found some expression, though but little execution, in the Revolution. The Convention prepared a scheme of improvement called the artists' plan, which was based on a complete and beautiful survey previously prepared by Verniquet for Louis XVI. Napoleon I. appropriated the traditions of the monarchy by providing public monuments; he completed the scheme of the Place de la Concorde by the erection of the Corps Législatif across the river, erected the Arc de Triomphe, the Vendôme Column and the Arc du Carrousel, and projected a palace on the site of the Trocadero on the axis of the Champs du Mars. A more important scheme of Napoleon's was the improvement of the Rue Rivoli with its arcaded and continuous front leading towards the yet undeveloped heart of the right bank at the east end of the Louvre. The new law of alignment defined the widths of streets and heights of buildings; the Rue de la Paix at the axis of the Place Vendôme, till then a detached piece of planning, was laid out; quays were formed, bridges reconstructed, side-walks introduced provided with lamp-posts, and the cemeteries made. The public artistic spirit which had been created, and was now characteristic of the nation, continued to improve Paris throughout the ensuing generation of the Restoration, completing the Arc de Triomphe and the Madeleine and erecting the Colonne de Juillet, as well as new outer fortifications.

Haussmann.

Napoleon III. affected successfully the part of successor to the principles of the Revolution. The practical improvement of Paris and of the conditions of existence was the professed ideal of his administration. The State and city together shared the cost of the great works that were undertaken, and in a large measure accomplished, during the twenty years of his power. The Emperor's great civic minister, Georges Eugene Haussmann, was born in 1809 of a Protestant Alsatian family; he was a lawyer in the public service, and attained to the Prefecture of the Gironde in 1852; in 1853 Napoleon transferred him to that of the Seine. Haussmann's name is identified with the process of transforming a historic city, still having much mediæval character with disconnected Renaissance monuments and unconnected modern improvements, into a coherent, characteristic and magnificent whole. It is right to credit him with the genius that made Paris into the finest city of the world in the nineteenth century. He had a willing master, who had endeavoured improvements before bringing him up from the provinces; but the difficulties were as great in securing success as we could imagine them to be in London. The engineers, architects and inhabitants, the finance, the legislature and municipality had all to be dealt with and combined in agreement before execution could be achieved, and for all this the office of the great Prefect supplied both the power and direction. In Haussmann's work are evident a complete grasp of the problem of the city as a whole, of its historic life and active development, of the necessity for drastic and wide opening out, modified by the wise conservatism of employing existing routes, together with the comprehension

of the zones of traffic and attention to the underlying success of architectural effect. The reassertion of the main Cross of the Roman plan was accomplished by the completion east and west of the Rue de Rivoli to the Place Bastille, in its progress clearing out the evil heart of the city between the Louvre and the Hôtel de Ville. The reconcentration of the civic life was thus effected on the historic centre from which it had drifted westwards. The reformation of the island was secured without confinement or restriction by the very skilful development of the Place du Châtelet on the right bank and the Place St. Michel on the left. The great boulevard system, concentrating in fixed lengths at points of importance and intersection, follows the historic double bulwarks of the city; the result seems magnificent and simple, but the difficulty of giving effect to single and separate improvements makes one marvel at the completeness which marks the plan of Paris in Haussmann's view.

It will be idle now to compare the situation and conditions of London with that of Paris, but it may be safely asserted that the problem here, though larger, is not in its material aspects more complex than that of Paris. The difficulties that lie in the way of a scheme that would make London take the place architecturally that its wealth and influence demand—that is, the most interesting and beautiful city of the world—are of another character. Within the nation, either concentrated in a tyrant, distributed through a governing aristocracy or an educated democracy, there needs to be engendered a sense of the dignity and value of civic existence, ceasing to regret the city and sigh for relief from its dull stupidity of outlook, for this is what Haussmann achieved for the Parisians.

Modern Germany and Austria.

Germany and Austria moved in the wake of Italy and France through the eighteenth century. In the smaller royal and ducal capitals interesting and large schemes were laid out, as at Stuttgart and Dresden after the Thirty Years' War. These represent a movement of individual effort and taste which ceased to have force after the French Revolution.

From the later nineteenth century until to-day the new and great developments at Vienna, Buda-Pesth and Berlin form a chapter in the history of town-planning of great interest and importance. It would be generally true to date the marked increase of progress in these cities from the Franco-German War, though it only affected Berlin directly. The operations of political, commercial and social causes underlie each in different degrees, but it may be confidently asserted that an enlightened and competent grasp of the value of a science and art of town-planning was a main factor in securing the pre-eminence and providing for the healthy growth of these capitals.

Vienna, an ancient seat of historic empire, would have succumbed to the new rivalry of Buda-Pesth but for the enormous civic undertakings that retained the old and attracted a new commercial life. Much of its social importance as the Central European capital has become distributed between Berlin and its fellow capital of the dual monarchy, Buda-Pesth. The municipal policy of development, however, in spite of the shifting of the aristocratic centre, has proved strong enough to maintain the primacy of Vienna in population, manufactures and intellectual life. The removal of the fortifications took place soon after 1859, providing a series of sites that have been skilfully disposed for the series of fine public buildings which encircle the mediæval city and royal palace, and outside this ring great quarters have been laid out connected by a metropolitan railway. The cherishing of the University and of the national love of music by the authorities have also served to maintain the priority that was threatened by the State recognition and growth of the Hungarian capital.

Buda-Pesth has provided, in little more than a generation, the most remarkable demonstration of the art of civic development, occasioned mainly by the political enthusiasm of the Hungarians, who have felt the impulse of its beauty. The removal of slums, the consequent rebuilding and development of traffic, the erection of buildings for the arts, sciences, and for higher education and great State offices, have been accompanied by State action, through the railway concentration and by a zone of special rates, also by inland navigation, all designed to further the commercial interests of the national capital in its competition with Vienna. The strong but narrow nationalist spirit tending to a monopoly of the home market for Hungarian industry has been potent in forwarding civic architecture and development on an aggressive and impressive scale.

Modern Berlin is a direct fruit of the war of 1870–71, for it seems to be possessed with the intention of becoming to the ensuing generation

what Paris had been to the past and of surpassing its former ideal and guide. The immediate expansion of the capital was hurried and unsatisfactory, but this was soon followed by definite ideas. The political importance of the city led to an organised development and enrichment that has been continually justified by commercial expansion and wealth. The largest political aims are expressed in the concentration of the railway system and of the State buildings, as well as by the wearying insistence of grandiloquent military and imperial statuary. About five miles from its centre the city is surrounded on three sides by a forest belt into which suburban residences have gradually extended, beginning with one villa colony, and now extending beyond Charlottenburg and almost to Potsdam. Imperial, municipal and private enterprise in combination have thus controlled and compelled the development of Berlin into the most important of European cities. It is as full of lessons of civic development to the modern as Babylon was to the ancient world, and it may be that the Assyrian characteristics of its political ideals are preparing for it a similar retribution of enduring feebleness and monition.

To German architectural theorists belongs a pseudo-romantic theory of planning streets and towns. The picturesque accidents of the mediæval fortress-bound towns of which Nuremburg is a type are welcomed as embodying ideas and principles of design that could be reproduced, not only in a modern suburb, but in the scheme of a town. This is a curious effect of the study of the later works of the Gothic revival in England that has carried the cult of the picturesque from the comparatively narrow and innocuous sphere of fanciful domestic building into a larger and more important world, where it is at once in conflict with economical and practical life on a large scale, and with which the doctrinaire designer wrestles in vain. The compensating advantages of curving street lines may be admitted, as well as the primary one of directness, without committing the mistake of regarding as scientifically achieved and premeditated results accidents which compelled distortion, or treating as a virtue the ignorance of our forefathers of modern locomotion or sanitation. Thus the ideals of the Renaissance culminating in their modernisation at Paris are now to be considered outworn, and the modern world is treated to a theory of mediæval prescience that has no existence outside the curious uncombined mixture of Teutonic idealism and practical-mindedness. It is interesting in this connection to recall that Dr. Stübben, one of the most distinguished German authorities on town-planning, at the Congress in London in 1910 exhibited his scheme for the reconstruction of the old town of Louvain in Belgium, devised, he told us, "to save such of the old gabled houses as possess artistic interest." His plan showed a new street leading up to the front of the cathedral, and the formation of a garden on the site of the old slaughterhouses. On the same occasion Dr. Stübben exhibited and described his plan for a new town called St. Anne, to be constructed on the banks of the Scheldt, opposite Antwerp. This is a great scheme, well developed and apparently practicable, designed to secure in a central vista the tower of the cathedral, the new town being connected with the old by two great subways under the river. In passing from these references to pious Teutonic town-planning schemes, it must be emphasised that no student of the subject can afford to neglect the work that has been done in the facts as well as in the theory and literature of town-planning by recent German architects and writers. That these are the product of much official direction and encouragement clearly bestows advantages that we do not possess, but it lies before us to employ our best endeavours in arousing public spirit at home to undertake schemes that will result in improved social conditions.

America.

In turning for a rapid observation of the New World, that knows neither Pharaoh nor Nebuchadnezzar, Nero nor Napoleon, being born free of the imperial traditions of city destroyers or builders, we anticipate that the democratic freedom of which America is so justly proud must be justified in origination by civic discipline and in result by the test of beauty. The city of Washington possessed from its inception the plan of Major L'Enfant. The situation of the Capitol building, at the junction of a great system of cross and radiating roads, fronts to an elongated park which extends for a mile and a half to the river, and forms a return transeptal avenue above its base providing a central site for a great monument. Both genius and practical mastery are evident in the scheme; it is very dignified, and the planning of the splendidly wide streets of the residential quarters befits its purpose as the initial capital of the United States. The lapse of a century has seen the

ebb and flow of the spirit and purpose of the people to fulfil this admirable design. The neglect of a couple of generations has had to be repaired by the recovery and re-dedication of sites in the central reserve for the State buildings with their growing requirements. In this restoration and development the voluntary services of the most capable artists and administrators of the State have been concentrated in a commission, with results of great value.

Chicago is an instance of the combined study of the problems of a great and extending commercial city by a commission of artistic and administrative citizens: this issued in the production of a really impressive scheme by the late Mr. Dan Burnham that offers, not only a highly practical traffic plan, but the creation of an architectural civic centre on a vast scale. The characteristic eloquence of idea is here: the imaginative possibilities of a great city have been felt and embodied in a scheme wholly conceived from the standpoint of the community and citizen. More than at Washington, which is necessarily imperial in motive, the Chicago plan speaks the ideals of the New Democracy of the West.

But though we are assured that many cities are also engaged in considering the scientific and artistic reform of their plans, the pace of civic development is compelled by commercial prosperity more rapidly than will permit their considered and obedient growth. San Francisco has had the benefit of an earthquake, as Chicago had of a fire; but New York, the gateway and Sublime Porte of the New Universe, apparently suffers from evils in its plan and architectural requirement that cannot be remedied short of a drastic cure that would be disastrous. Its problem is as special as that of London, and to a stranger seems more insoluble. The miles of parallel streets, the congestion at the heart, the absurd effervescence upwards, the traffic and overcrowding, and the enormous concentration of wealth in piles that scrape the sky, are as much the uncomfortable fruits of freedom from artistic tradition as from political autocracy. Democracy, however, must believe in herself, and such faith will doubtless erelong courageously undertake tasks from which there appears no way of escape to eyes accustomed to a milder and less clear atmosphere.

Lecture IV.—Delivered February 19th, 1917.

In a general review it becomes apparent that town-planning has been slowly forced into prominence in England, not by architectural consciousness, but by insanitary conditions and inconvenience in towns of hasty growth and unregulated development — conditions which have not arisen from poverty nor stagnation, but from sudden wealth and what is denominated as progress. Financial prosperity has been accompanied by civil misery, and commerce in its base of action has made necessity a vicious excuse for neglect of the virtues of a decent amenity of existence. Unregulated cheap housing is the great and often overwhelming by-product of the expansion of manufacturing towns; its miserableness is an evil scarcely yet recognised by the parties most concerned in its creation or by local or central State authorities. When this aspect is more widely realised in a body politic that is essentially healthy, town-planning should become universally obligatory and a constant, not exceptional, function of municipal life.

Beneficent compulsion is implied in sanitation as a principle of communal existence. A recent enactment has undertaken the superficial reform of unsanitary individuals—a short and hesitating step to tyranny, but involving all that is required to justify the ordering of dwellings and the cleansing of streets. The programme is logical, and illustrates the trend of an argument from the history of modern legislation towards a conclusion that is yet to be attained in whole townships.

A town inevitably reflects the ideals of its makers, but only indirectly at present those of the inhabitants, who for the most part dwell of necessity in its streets. The demand for suitability and dignified beauty in public edifices of all kinds and in their convenient location is natural, and always witnesses against the Philistine in spite of his constant objection to sentiment. The arrangement of buildings and streets gives character, for good or evil, to a town, and this if considered at all is an art that cannot be separated from the planning of areas for public, commercial or residential purposes, or from considerations of traffic and thoroughfares. Education surely tends to amenity; national art training, however imperfectly related as yet to public ends, has the effect of maintaining a conscience that recognises beauty in its simpler expression through the surroundings of daily life as beneficent, not only to the individual, in matters of personal taste, but as a necessary element of civilisation.

The formation of roads has of necessity been in operation throughout English history, but previous to 1909 had not been subject to any

comprehensive law dealing with their design, in relation to the extension of the towns that they both assist to create and serve, and the legal connection between roads and housing may be described as accidental or fortuitous.

Venerable highways stretch back into antiquity without any method of common law for their extension or creation, except it be by private dedication of land, but bridges and their approaches, throughout English history, have been a charge upon the country. The formation of villages and towns has remained a subject of "natural" development by the miscellaneous aggregation of dwellings and buildings of all kinds upon roads, placed as the law of supply or private circumstances demanded.

Turnpike, Improvement and Private Acts began to multiply in the eighteenth century, until the era of Parliamentary and municipal reform and of the Poor Law Acts in the first half of the last century. The slow but effective growth of a sanitary conscience in public self-government is evidenced by the Public Health and Local Government Acts, dealing progressively with admitted evils by organised authorities, and the creation of the Local Government Board, in succession to the General Board of Health in London, provided a central department that acquired authoritative experience, though without power to enforce any originating action upon a local community. The Road Board, formed under the Development Act of 1909, is a recent and promising innovation if administered with courageous foresight, providing funds as a department of the Treasury for road improvement and formation.

The method adopted, the best part of a century ago, by the great landowners in laying out and managing the building estates which encircled London at a radius of from two to three miles have, by the planning of main streets and enclosed squares, saved the older suburbs from the almost unalleviated welter of the inner as well as of the outer circle in this hugest of cities. The benefits afforded to the community through the operation of mutual building and other covenants more than counterbalance the often proclaimed drawbacks of the leasehold system. A discerning eye can recognise the freehold patches in the area of London by irregular buildings, often unsuitably occupying important sites, and by unchecked dilapidation adjoining expensive rebuilding. The charms and privileges of an effective freehold are for the country rather than for the town, where it is essential that communal obligations must involve a sacrifice of individual liberty. It is scarcely too much to say generally that the character of the modern parts of our towns has been saved from entire disrepute by the leasehold estates.

The responsibility of the controllers and purveyors of industry to their workers, probably, has been as often admitted and accepted as neglected. The public spirit of wealth exhibits some of its best efforts in the town-planning and housing undertaken by commercial capitalists, as well as by great landlords. Many industrial kings have provided and laid out residential districts furnished with public buildings, places of worship, and amenities. It is not possible here to enumerate or describe them, but the national debt to exemplars of the duty and profit of caring for one's neighbour as oneself should be acknowledged.

A full generation ago Sir Titus Salt founded. Saltaire, near Bradford, for his employees. Prosperity has rested upon this well laid out Victorian town; as a venture it was furnished with a public park, endowed schools, secondary, elementary and technical, and a library and other advantages, together with the credit of pioneering cottages having separate sanitary accommodation. Many colliery proprietors have set and followed good examples—one at least can be pointed out, at South Hetton, in Durham, which for many years has been smokeless. The works and townships of Messrs. Lever at Port Sunlight, and Messrs. Cadbury at Bourneville, are well-known illustrations of good intention fulfilled with almost a superfluity of picturesque patronage.

These later developments preceded and showed the way to the Garden City movement, identified with the reasoned enthusiasm of Mr. Ebenezer Howard, neither an autocrat, capitalist, nor manufacturer, but who has earned the fame of one "who by his wisdom delivered the city . . . whose wisdom was more than strength, and whose words are heard in quiet more than the cry of him that ruleth among fools." Mr. Howard, after many years of investigation, in 1898 published a book entitled "To-morrow," based upon the thesis that "a city which is to be the outward expression of a strong desire to secure the best interests of all its inhabitants can, among a self-governing people, only arise as the outcome of much patient and well-sustained effort," and that "the building of the first of such cities necessarily involves co-operation on new lines, in untried ways . . . a project that indeed touches life at every point, and when once carried out will

be an object-lesson which must have far-reaching and beneficial results."

Mr. Howard disclaimed being Utopian, though, in fact, he is so essentially, with the qualification of practical. He lectured upon his scheme of a garden city first in London in December, 1898, repeated his views at various places, and six months later founded the Garden City Association with a membership subscription of 1*s*. Influential and effective aid soon came to the movement, so that the Garden City Pioneer Company, Limited, was formed, and the Letchworth Estate of about 3,300 acres was acquired by this company in 1903, "not as a speculation, but with the primary object of promoting a great social improvement by dealing at once with the two vital questions of overcrowding in towns and depopulation in rural districts." He describes this as a stage in the process of migration from crowded centres to new areas, broadening the idea of a well-planned village of one industry into that of a town of many industries; introducing also the added elements of residential and agricultural populations, so as to give more life, colour, variety, and stability to the enterprise by combining the advantages of town and country life. Subsidiary companies undertook the housing of the working class, the first being a co-operative society The Garden City Tenants, and then the Letchworth Cottages and Building Company, Limited.

The Garden Suburb movement works between complete ideal cities and the improvement of extensions to existing towns, and its achievements are now patent. The vigorous and really splendid example at Hampstead well illustrates what enterprise in co-operation with a reasonable local authority can accomplish, for it is to be remembered that this scheme was antecedent to the Town Planning Act of 1909. Large-hearted liberality and courageous experiment with the disposition of the land and roadways here produced results that indicated the reforms in by-laws and by proving their success secured for them embodiment in legislation. The whole of this estate offers models in which almost everything that the designer of a residential suburb requires to know may be observed.

Many developments subsequent to the Act of 1909 have been initiated, the consideration of which would be fruitful but long. One of the more important is at Birmingham, where the restriction of houses per acre has presented difficulties owing to the neighbourhood of districts in which the restriction was non-existent, thus pointing to the necessity of spreading the town-planning net very widely. The Ruislip-Northwood, Middlesex, scheme is extensive, and has been thoroughly worked out: it is a private promotion dealing with the estates of King's College, Cambridge, and illustrates the possibilities of a great scheme not promoted by a local authority, but which now has acquired full legal status.

The title of the Housing, Town Planning, etc., Act, 1909, is significant of twin movements in the pressure of civic growth and the education of public opinion in the necessity of amenity. The first part of the Act, containing fifty-three out of a total of seventy-six clauses, is an extension of the Housing of the Working Classes Act of 1890; it provides facilities for the acquisition of land, enforces the execution of Housing Acts, and deals with repairs, landlords, closing orders, improvement, reconstruction, finance and cognate matters. It is eminently practical and sanitary, and compulsorily beneficent in its aim, "to keep the simple folk by their right, defend the children of the poor . . . and be favourable to the simple and needy."

This part of the subject of the Act has assumed a new and serious importance through the enormous demands of the war; the general suspension of house-building that has been forced upon the country presents a problem the gravity of which is but partially realised, in view of the normal increase of the population and the resettlement and housing of the armies of soldiers, sailors and munition workers. A congress organised by the National Housing and Town Planning Council in April, 1916, resolved to urge the Government that a sum of twenty millions sterling should be provided to make advances to local authorities and other agencies for the erection of houses for the working classes. Mr. Walter Long, then President of the Local Government Board, received this request sympathetically, though then unable to make any promises on behalf of a Government that was solely immersed in the conduct of the war. It followed upon the realisation of the condition of affairs that the congress urged upon all local authorities the necessity of preparing town-planning schemes for immediate action. The first civil requirement of peace is homes, and a second not unimportant consideration is the remunerative employment in building operations of those at first set free from munition-making.

The second part of the Act deals with town-planning, for the first time bringing under statutory control the laying-out of roads and the apportionment of districts in town development. Constitutional England has thus advanced to a stage at which both the sanitary and architectural growth of cities can be organised by due authority. This organisation, however, is not imposed by a central disinterested Government Department, for, so far as town extension is the object, the design is to be home-made and entirely local in conception, the community concerned undertaking the grouping of its varied elements.

The interest that promotes the scheme may be that of a landowner, of a speculating builder—in whose irresponsible hands has lain the modern development of towns—or of a manufacturer in search of eligible sites for works and workers' dwellings, or of other adventurers in real estate. The origination of a town-planning scheme, however, may and should primarily proceed from the local authority, though it is not dependent upon an official initiative which may be indolent or ill-informed.

A local authority or members of the community now possess the right to plan the growth and development of the area of their town upon the surrounding lands, whatever may be their ownership—that is, to prepare the design of all or any intended roads; to fix the number of houses per acre, a radical provision striking at the root of overcrowding; to propose the amendment of existing by-laws, an important reform affecting widths of roads, lines of frontage, and other matters in which statutory fixed rules of the best theoretical intention have worked many practical evils; and, as if a ducal landlord, to determine in the scheme which shall be the residential or manufacturing areas in relation to the town; there is also power to remove existing buildings and streets that would mar the plan.

(*To be continued.*)

THE RELATION BETWEEN FORESTS AND ATMOSPHERIC AND SOIL MOISTURE IN INDIA.

An interesting discussion of this subject by Mr. M. Hill is published in the *Forest Bulletin*, and epitomised in the *International Review of the Science and Practice of Agriculture*, as follows:—

For over half a century special laws have been passed in India for the protection of hill catchment areas by making reserved forests and protected forests; these cover respectively 96,867 and 8,492 square miles. This Report gives the result of an inquiry organised by the Government of British India in order to determine the relation between the forests on the one hand and atmosphere and soil moisture on the other.

The examination of abundant material collected in all the provinces shows that the protective measures which were introduced during the last decades, and carefully carried out, have decidedly prevented deforestation in districts where the effects of the denudation of the country had begun to be most severely felt. These measures were, moreover, taken at the right time. During the first half of the nineteenth century the destruction of the forests proceeded apace, as agriculture developed and villages increased. While the contractors cut down jungles, the villagers did still more harm by uprooting stumps, grazing cattle on the young growth and firing the hill-sides. The effect of such action was seen in the rivers, which became torrential during the flood season and shrank or dried up in the hot weather. This was the condition of affairs in the Province of Bombay, the Presidency of Madras (the district of the Parlakimedi Maliah Hills and in the hill tract of Vizagapatan), and especially in Chota Nagpur, Orissa, and the Feudatory States.

The United Provinces, and particularly the large fine oak forests of the State of Tehri-Gahrwal, had suffered greatly from deforestation, as had the Siwaliks, the Salt Range, the Pabbi Hills, and the Kangra District. In the neighbourhood of Simla the forests of pines and of oaks had been cut down to provide ground for potato-growing, while the same destruction had occurred on the Myelat Plateau in the South Shan States, near the Chinese frontier.

In the inquiry made by the Government of British India information was chiefly required on the three following points: (1) The rainfall; (2) differences in the level of the underground water-table; (3) the flow of rivers and streams.

1. *The Rainfall.*—During the last fifty years there have been no permanent changes in the rainfall which cannot be directly connected with the monsoons—winds caused and regulated by atmospheric changes in zones at a great distance from India, and therefore unaffected by local afforestation or the destruction of existing forests. The data collected, however, lead us to infer that forest may increase rainfall to a certain limited extent (which does not reach 5 per cent.) by promoting the condensation of aqueous vapour.

2. *The Level of the Underground Water-table.*—This has not altered during the last fifty years; it depends on the rainfall and varies directly with it.

3. *The Flow of Rivers and Streams.*—This is

the most important point of the inquiry. The chief data may be summarised as follows: In Eastern Bengal and Assam, even of late years, some small amount of forest denudation has taken place, but the rapid growth of vegetation on areas abandoned after cultivation has tended to neutralise the injury caused, which was not very extensive. In the United Provinces the only definite case in which floods are believed to have been more violent and of shorter duration is in the torrents of the Siwalik Hills; but this is certainly not due to the destruction of the forests, which have not been destroyed or encroached upon for thirty years.

The conclusion arrived at in Bengal, where in recent years destructive floods have been frequently caused by the rivers which discharged through the lowlands of Orissa, was that it is at least probable that denudation of the catchment area has been a contributory cause of these floods.

In the Central Provinces it cannot be said that any wholesale denudation of forests has taken place; indeed, in some places the forests have improved rather than deteriorated. The same may be said of the Presidency of Madras. In accordance with these facts, the flow of the rivers and streams is equable. In the Punjab the landslips, violent floods in the rivers, and the washing away of all cultivated soil in the Pabbi Range, the Hoshiarpur Chaos, the Siwaliks, the lower Himalayas, and the Salt Range are doubtless due to the denudation of forest growth.

It can therefore be said generally that in most provinces no serious damage to the flow of rivers has taken place, and no great injury has been done to cultivation. There are, however, local exceptions, and much damage has been done in the Punjab, in Bengal and Assam. Where damage was acknowledged, it was, on the whole, admitted to be due to forest denudation, which changes the flow of the streams and accentuates their torrential character.

It may therefore be said that the measures of forest conservancy adopted by the Government of India during the last fifty years have entirely satisfied the climatic and hydrographic requirements of the country, and have resulted in the preservation of a sufficient area of forests, so that no widespread damage arising from the destruction of forest growth has occurred. This is chiefly due to the formation of reserved and protected forests in the large catchment basins, and if, as has been said above, inundations and floods have occurred in certain districts, these are due to the measures for forest protection not yet having been definitely enforced in these parts of the country. In fact, whilst the forests under the control of the Forest Department occupy 22·1 per cent. of the combined areas of all the provinces of India, their distribution is very unequal. Bombay has, approximately, 10 per cent. of forests; Madras, 13 per cent.; Central Provinces, 20 per cent.; Bengal, 13 per cent.; Burma, 59 per cent.; Assam, 46 per cent.; whilst the Punjab has only 9 per cent.; the United Provinces, 4 per cent.; and Béhar and Orissa, 3 per cent.

LAND SETTLEMENT FOR DISCHARGED SOLDIERS IN ONTARIO.*

The Province of Ontario has now completed the arrangements for a land colonisation scheme by which discharged soldiers who have served with the British Forces are offered the opportunity of securing homes in New Ontario.

All men who wish to go upon the land will first be sent to an agricultural training depot, where they will be provided with good board and living accommodation during their period of instruction, and where they will be paid a reasonable wage for work done. As soon as a sufficient number of trained men have accumulated, a farm colony will be established along the line of the railway. The colony will be in charge of a competent superintendent, under whom the men will proceed to do whatever clearing may be necessary, erect the necessary buildings, and do such other work as may be essential to the establishment of a central community. The men will be housed and cared for in the central community, and paid a reasonable wage, and their labours will be directed to clearing and preparing for cultivation the land of the colony. Farms containing not more than 80 acres will be laid out in such manner as to bring the different farmhouses as close together as possible, and an area of 10 acres will be cleared on the front of each farm.

As soon as a soldier desires to go upon a farm and work for himself, an 80-acre lot with a 10-acre clearing will be allotted to him. He will be supplied with the necessary machinery and tools, and such cattle, pigs, poultry, etc., as the competent authority may determine, up to the value of $500 (£100). The 80 acres, with 10 acres of clearing, will be given to the settler free of charge. For the advance of $500, made to cover the cost of stock, implements, equipment, and any assistance in building that may be given, a lien will be taken against the settler's holding and chattels. The lien will be repayable in 20 years, at 6 per cent., but no payment on account of either principal or interest shall be required until after the expiration of three years. At the expiration of five years from the time the settler takes up his land, and upon the observance of certain conditions during that time, he will be entitled to receive a patent from the Crown.

The community system will apply with regard to the provision of horses and other stock and implements, a supply of these being kept at headquarters for the use of the settlers on easy terms. Buying and selling will be done upon a

* *The Agricultural Gazette of Canada*, Vol. IV. p. 306, 1917.

co-operative basis, and every effort will be made to establish the men quickly upon a prosperous and independent footing.

The social side of life at the colony will not be neglected. A proper public building, where both religious and secular gatherings may be held, will be provided, also a school-house and educational facilities. Arrangements will be made at an early date for married men to have their families with them, and, as far as possible, discharged soldiers with practical experience will be employed to direct the affairs of the colony.

Soldiers who may desire to go into fruit-farming and chicken-raising, or other specialised branches, will be given free instruction at the public institution of the province.

AMERICAN TRADE AND THE WAR.

The *Weekly Financial Review* of the banking house of Messrs. Henry Clews & Co., of New York, contains some remarkable figures relating to American trade during the war.

The submarine campaign, says the circular, has met its answer in our foreign trade returns. During the fiscal year ending June 30th, our overseas trade aggregated $8,953,000,000, which was the largest total on record, and exceeded the previous record of 1916 by over $2,400,000,000. The relative impotence of the submarine was further illustrated by the fact that our exports, which are naturally objects of keener attack than imports, amounted to $6,294,000,000, or $1,960,000,000 more than a year ago, which was the previous banner year. The excess of exports over imports for the year was $3,635,000,000, against $2,135,000,000 a year ago. So much for the submarine, which was to destroy the commerce of Germany's enemies and frighten them into submission, but has done neither. On the contrary, our commerce has grown enormously, and that of Great Britain has been practically sustained at nearly normal figures in spite of the British loss of tonnage. The submarine policy, instead of frightening Germany's enemies, has simply made them more determined than ever to win this war, and exact retribution for inhuman methods. Another stimulus arising from the German submarine policy, which is acting for our benefit and German detriment, is the wonderful development of American shipping. In July new shipping and shipbuilding concerns with an authorised capital aggregating nearly $20,000,000 were incorporated, making $330,000,000 since the war began. The bulk of this total, or $226,000,000, has been announced since January 1st. Such extraordinary development of American shipping would not have been possible within so brief a period but for the German submarine. Great Britain, the United States, Japan, Holland, Norway and Canada are building ships to-day at the rate of probably more than 5,000,000 tons per annum, compared with losses of about 7,000,000 tons or less. As the world's tonnage is about 40,000,000, the chances of submarine success are growing less and less in view of the rapid increase in shipbuilding, and the more efficient methods of dealing with the submarines. Incidentally, it is worth noting that new shipbuilding is being accelerated much more effectively by high freight rates than by any Government action, since all efforts by the Government toward regulating freights or keeping down rates promptly discourage private enterprise. One other lesson in our foreign trade returns must also be noted, and that is the wisdom of this country having so liberally aided in financing the war. The enormous increase in our exports noted above is almost entirely due to the liberal purchases of our Allies, which would not have been possible without the extensive credits and loans that have already been granted them. This policy of aid not only greatly stimulated our foreign and domestic trade, but also immensely strengthened our credit resources through gold importations, giving us a status as a great commercial and banking nation which would not have otherwise been possible, even by years of strenuous competition.

INDIAN OIL-SEEDS.*

The Indian export trade in oil-seeds and vegetable oils is worth annually over 16½ million pounds sterling. Only about one-third of the output is exported and the remainder is used in the country, the local consumption of oil, both for cooking and toilet purposes, being enormous. After the outbreak of war the exports of oil-seeds have naturally declined. This, with the resulting low prices, has affected the acreage, but the trade in oils has, on the other hand, shown signs of improvement. Although the crops offer a large field for improvement, it has not been possible yet to devote to them any large measure of attention. The oil-seeds that have attracted notice at present are groundnut, sesamum and coconut.

There has been an extraordinary expansion of groundnut cultivation in India within recent years due to the successful introduction of the crop in new localities. The introduction of foreign varieties, which give larger yields and are not susceptible to disease, has also helped the expansion. The area increased from 431,000 (average of 1900-01 to 1904-05) to 2,413,000 acres in 1914-15. There was a reduction of 20 per cent. during the year under review, owing to a variety of causes. The figures relate only to Bombay, Madras and Burma, where the crop is grown on an extensive scale. The testing of different varieties goes on at experiment stations, and the possibilities of introducing the crop in new localities are being investigated. In Burma the crop is of only recent introduction. From a small beginning in 1902, it now occupies 262 thousand acres, and there are signs that its cultivation will expand in new areas as a result of trials on experiment stations. On light sandy soil of the Hopin Experiment Station

* From the Report on the Progress of Agriculture in India for 1915-16.

it gave very good yields during the last two years, and the crop seems likely to be taken up by cultivators in that tract, as the net profit per acre from its cultivation has been estimated to be Rs. 47 as against Rs. 12 per acre from paddy.

Of the total area under groundnut in the three provinces named above, Madras Presidency alone accounts for about 75 per cent., and as it has also the largest share in the export trade in this commodity, the Department has naturally paid considerable attention to this crop. There is a special experiment station where thirteen different varieties are being tested for yield of nuts and oil, and the best methods of cultivation are being studied.

The crop has also been introduced in Mysore, the United Provinces and the Central Provinces. It is mainly grown here for eating purposes, but as it does well even on light and poor soil, and is a good crop for rotation, it is readily taken up by cultivators when its suitability to a particular area is demonstrated.

With regard to sesamum, a preliminary classification of the varieties has been undertaken in Burma, where the crop covers something like a million acres annually. The oil is largely used in cooking, while the cake is utilised for feeding cattle. About 145 single plant cultures were made during the year under review at the Tatkon Agricultural Station, and are being tested with a view to further selection for yield, earliness, quality of seed, etc. In the Central Provinces, a variety was selected some years ago on the Hoshangabad Farm, the profits from which are Rs. 4 to 5 per acre more than those from the local variety. Its seed is being distributed from seed farms, and about 23,000 acres were sown with it by the cultivators in the tract during the year under review.

As regards coconut, this industry is most important in Malabar and Travancore, where the finest quality copra is produced, and a very large trade has recently sprung up in the export of copra for the manufacture of vegetable butter. The importance of the coconut palm-tree in South India may be gauged from the fact that the value of exports of its various products during 1914–15 amounted to over one and a half million pounds sterling. The trade has suffered owing to the war, and the exports during 1915–16 declined by more than 50 per cent. As the industry is capable of extension and offers great possibilities for improvement, the Madras Department of Agriculture opened during the year under review three special experiment stations for the study of this crop. In the Travancore State different varieties are being tested, but the trees have not yet borne fruits. Manurial experiments have given very promising results in this State, and the advantages of proper manuring are being largely demonstrated. A mixture of 10 lb. oil-cake, 20 lb. ash, 2 lb. bone-meal and 1 lb. salt every year has increased the yield of 10 trees on the experimental farm from 44 nuts in the first year to 919 in the seventh year. Similar results have also been obtained by manuring at the Coimbatore Agricultural Station.

TINSEL AND METAL FABRIC INDUSTRY OF FRANCE.

The history of the manufacture of tinsel and metal braids and fabrics in France goes back, according to the records, to the eleventh century; but it has only been within the past half-century that a real commercial development of the art has been noted. To-day France leads the world in the manufacture of tinsel fabrics, and the city of Lyons is easily the first in this industry.

In 1583 thirty establishments were producing metal braids and fabrics in the city of Lyons. Three-quarters of a century later the number had increased to eighty, while at the present time thousands of workers in Lyons and its environs are engaged in the manufacture of metal threads and fabrics.

The regular trade for tinsel goods was formerly limited to the uniform of officers of the army and navy and of the diplomatic corps, and to church vestments, church banners, and ornaments for the decoration of Christmas trees. Now, however, a large quantity in various forms is also employed in the manufacture of women's dress goods, which, in large measure, is responsible for the big increase in the production of tinsel goods.

Lyons has always been recognised as the principal market for tinsel goods in France. Before the war its greatest competitor was Germany, but the supply from that country having been cut off, Lyons has been called upon to supply the world with its tinsel products. It has been impossible to supply the demand, and as a natural consequence prices for all articles in this category have more than doubled, and some have even tripled and quadrupled in price.

In Lyons and its environs a number of important factories are engaged in the production of metal thread, trimmings, and braid. The merchants of Lyons furnish these factories with certain materials in an advanced state of completion, and the factories turn out the finished product.

Up to fifteen or twenty years ago a large proportion of the goods manufactured in this trade was completed in the city of Lyons. In these days, however, the work is largely done in the country districts through organisations that control a large supply of expert but comparatively cheap labour.

Those engaged in the manufacture of tinsel goods in the country districts do their work at their homes, either by hand or by primitive machines that have been handed down from previous generations. It is estimated that 80 per cent. of the workers are women, and as the work is not arduous many are attracted to it. The articles manufactured by the women include fringe bullions, laces, embroideries, and church ornaments, as well as tassels, fancy trimmings, military regalia trimmings, theatrical goods, church vestments, and articles for upholstery and the box-making trade. It is estimated that between 50,000 and 75,000 are employed in the tinsel trade.

The scale of wages in the trade changes many times during a year, according to the demand, and specialists employed in the manufacture of certain articles receive additional compensation when those articles are in vogue; but the demand for tinsel goods fluctuates with the prevailing styles. Women in the small family workshops average 1*s.* 8*d.* to 4*s.* per day.

These people bear a high reputation in the commercial world for honesty and faithfulness, and they often hold £200 worth of raw material belonging to large establishments in Lyons.

At times advances are made for the purchase of certain material, but the looms and other machinery are usually the property of the person executing the work. Societies operating on a co-operative basis help the poorer working men to purchase raw material at advantageous prices, giving him long terms for payment and exacting no interest.

According to a report by the United States Consul at Lyons, one of the most interesting features of the tinsel trade of that city is the great variety of machinery employed, from the looms adapted for the manufacture of veiling and gold lace, costing from £400 to £4,000, to the crude machines used in the manufacture of ribbons for galloons that have been in use since the days of Louis XIV. Jacquard machines operated by electricity are used in the more advanced factories, but the desire for new methods in labour-saving machinery is not pronounced. The Lyonnais workman preserves the old methods of doing business that have been handed down to him through the ages.

Metal thread is almost entirely made by machinery. In the factories or workshops where the thread is manufactured a large majority of the employees are women, who receive, according to the seasons, from 2*s.* to 4*s.* per day. The manufacture of metal thread is in itself a simple operation. The thread is composed of two materials, cotton and wire, although that used for military ornaments is composed of silk and metal. Some of the larger factories manipulate as many as 3,000 threads all at the same time. The cotton employed as a base for the thread is first spun into a thin thread and wound mechanically upon spools.

The wire which is employed as a covering for this thread is flattened under a metal roller and reeled on small bobbins. The flattening of the wire is a delicate process, and requires a certain amount of dexterity in order that the flattening be equal.

MODEL CITY AT HONG-KONG.

For a good many years, writes the United States Consul-General at Hong-Kong, schemes have been entertained from time to time for the erection somewhere in South China of a model city for the use of well-to-do Chinese. Chinese people of wealth and Chinese returning from the United States, Australia, and other sections of the globe with a knowledge of modern cities have felt this need, and in recent years several attempts have been made to launch such a project.

One scheme went so far as the organisation of a city at Heungshan, not far from Kongmoon and within a short distance of Hong-Kong. This city was established upon Chinese soil and by special arrangement with the Chinese Government. It was to have certain customs privileges; it was established upon modern sanitary lines; and its close proximity to Hong-Kong on the one hand, and its location in the part of China from which come most of the Chinese in America on the other, were expected to make it attractive. The city has made little progress, however.

The latest undertaking of this sort is for the construction of a model suburb of Hong-Kong along the most modern lines for the housing of wealthy Chinese. This plan involves the reclamation of a tract of land about a mile and a half long and a third of a mile broad, the construction of wide avenues and fairly wide side streets, the erection of forty-seven blocks of high-grade apartment, tenement, and similar buildings, and the establishment of a modern sewerage system and other public utilities. In spite of war and the uncertainties of finance, the company undertaking this enterprise has been formed and its plans completed.

Increasing numbers of wealthy Chinese from various parts of South China have been coming to Hong-Kong to make this city their permanent residence. The result has been a constantly increasing need for houses for such people and a growing demand on their part for homes so situated that they can be among their countrymen. Most of these new-comers have plenty of money for their needs, and some of them have considerable sums for which they seek profitable investment. Purchases of residential property in the lower levels of Hong-Kong by such people have changed the entire course of real-estate matters in the Colony. The organisation of this new suburb offers a way out of many difficulties, for it will not only afford this class of people the proper housing they demand, but will also offer a ready and safe investment.

The new suburb is to be located on the south side of the Kowloon Peninsula, the mainland portion of the Colony of Hong-Kong, two miles from the landing of the ferry from the city of Victoria (commonly known as Hong-Kong), and along the shore of Kowloon Bay near the native city of Kowloon. The site is to cover a tract about 8,000 ft. long and 1,500 ft. broad, embracing the foreshore only, but backed by hills from which several small streams emerge, the ravines affording considerable fall for drainage purposes. The reclamation is wholly a dredging undertaking. There is some doubt as to whether dredging machinery of sufficient capacity will be available at the present time for the company's purposes, but apparently

this is the only obstacle in the way of rapid progress being made upon the entire undertaking.

The reclamation of the land for this suburb is being undertaken by the original syndicate, the plan being that the construction of tenements, private residences, piers, and warehouses shall be undertakings of separate syndicates to be arranged later. Being on the mainland portion of the Colony, the site has the advantage of railway connections for piers and warehouses and to assist in its development generally.

The plan includes the erection of four piers, with space for warehouses if need for them arises, on the water front of the reclaimed land.

Unless delayed by a lack of machinery, it is expected that the reclamation will be completed towards the end of 1918.

OBITUARY.

LIEUT.-COLONEL RICHARD CHESTER-MASTER, D.S.O.—Lieut.-Colonel R. Chester-Master, D.S.O., King's Royal Rifles, was killed in action on August 30th. He was the eldest son of Colonel T. W. Chester-Master. He was educated at Harrow and Christ Church, Oxford. He joined the K.R.R.C. in 1893. He served through the South African War, going out with his regiment in 1896, and was present at Belmont, Graspan, Modder River, Magersfontein, Paardeberg, Driefontein, Sanna's Post, etc. He was mentioned twice in despatches, and had two medals with eight clasps. He was A.D.C. to Lord Milner, High Commissioner for South Africa, 1898-1901. From 1901 to 1908 he was Commandant-General and Resident Commissioner in Southern Rhodesia. In 1910 he retired and became Chief Constable of Gloucestershire, but at the breaking out of the present war he rejoined, and in 1915 was appointed Lieut.-Colonel commanding a battalion of the K.R.R.C. He joined the Royal Society of Arts in 1905.

GENERAL NOTES.

TIMBER RESOURCES OF NORTHERN RHODESIA.—Of the indigenous timbers of Northern Rhodesia, the most abundant of the native hardwoods is teak or redwood, which is used largely for work in contact with the ground, as it resists well the attacks of white ants, and is specially suitable for railway sleepers. Rhodesian mahogany is an evergreen tree, commonly found in Barotseland, and widely distributed in the sand belts. It yields a fairly hard timber, usually handsomely figured, suitable for cabinet work and joinery. Bloodwood, or "mukwa," is used by the natives for boat-building and paddles, but is a first-class wood for joinery and cabinet work, and is said to be gaining an increasing reputation for these purposes. The tree is found singly or in small groups scattered through the sand belts. "Mangura" is the Barotse name of a yellowish wood, of tough, fibrous nature, admirably suited for handles, spokes, etc. Pick and hammer handles made from it have been reported on by the Rhodesian railways as being superior in appearance and toughness to the imported articles, and it is thought that the whole of the Rhodesian requirements in this respect can probably be met from this source. The tree grows in the more inaccessible parts of the Barotse Plateau, in some localities almost to the exclusion of other timbers; but it is considered that regular supplies will be forthcoming shortly. The botanical identity of the tree yielding "mangura" wood is not known. Other timbers of possible commercial value are "mashuma," which attains a large size in the Zambesi Valley, and is suitable for waggon building and similar purposes, "mangwe" and numerous hard woods producing poles suitable for pit props.—*South Africa.*

IMPROVEMENT OF THE RIVER SEINE.—*Le Journal Officiel* publishes the text of a law, promulgated on July 27th, authorising improvement works on the Seine in the region of Paris, having for their object the prevention of floods and the improvement of navigation. The works comprise (1) the widening of the left arm of the Seine, known as La Monnaie, at Paris; and (2) the deepening of the bed of the river as far as Bougival. The total cost of these improvements is placed at 67,346,000 francs, part of which is to be borne by the City of Paris and the Department of the Seine.

PINEAPPLE FIBRE.—This fibre, according to the *Bulletin of the Imperial Institute*, is produced in fairly large quantities on the island of Hainan, South China, and on the Liu-Chow Peninsula on the mainland opposite. It is also produced on a smaller scale in Formosa, Hawaii and the Philippine Islands. In the latter, the fibre is made into fine fabrics known as piña cloth. For fibre production the plants are grown closer together than when fruit only is required in order to induce the formation of long leaves; or they may be grown under trees in partial shade. The preparation of the fibre involves very tedious manual labour, as the machine product is not of such good quality. and this is a serious obstacle to the spread of the industry. In Hainan the leaves may be gathered the first year, but it is more usual to wait till the second year, as better quality is obtained. About twelve leaves are taken from each plant, each leaf then being scraped on both sides to remove the green tissues. The fibres are then alternately macerated in cold water for six hours, then dried in the sun, for several times lasting about three days. In the Philippines, each layer of fibres is removed as it is exposed by the scraping; 50 to 60 lb. of fibre is obtained per ton of green leaves, which is very low considering the amount of labour involved. The combings from pineapple fibre are said to give excellent results for paper-making.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

CIVIC ARCHITECTURE AND TOWN-PLANNING.*

By PROFESSOR BERESFORD PITE, F.R.I.B.A.

Lecture IV.—Delivered February 19th, 1917.

(Continued from page 723.)

The public material interests that enter into the subject of town extension can be now co-ordinated and dealt with under the Act, having regard to civil self-respect, as to open spaces for healthy dwellings and recreation, and as to amenity in the arrangement of the whole to secure pleasantness for residence and convenience fot work. The free selfishness that has bred so much civic disorder is to be forestalled by design; without any real private loss the external growth of a town is to be planned for public benefit as well as use, and the risk of depreciation and nuisance that haunts suburbs brought under control; for if necessary, an owner may promote a scheme that involves his neighbour's property in order to avoid a short-sighted or self-determining extension, and the execution of a scheme so prepared may be imposed upon a local authority.

This extension of legislative action, that has added town-planning as an organised co-ordination between private and public interests to our local government, is worth more to civic art than any of the historic methods of authority, the fruits of some of which have been passed under review. This has come to pass in England out of the developing sense of that civil self-respect in sanitation that proceeds to demand order and amenity, and is to be brought into practice through the stimulation of local patriotism.

The programme for the exercise of these new and suggestive opportunities of thinking civilly is designed with a series of stages in order to avoid arbitrariness and to minimise the risk of blundering; it is set out in the second part of the Act, and should cultivate an inquisitive public interest by its opportunities for criticism. The stages briefly are as follows:—

1. The owners are notified that it is proposed to include their land in a scheme, and a plan called Map 1 is made showing these lands. As no lands can be afterwards added to those on this map during the subsequent progress of the scheme, it is quite necessary that any possible contingent development should be foreseen and included. The importance of this first step is that all lands included in Map 1 are from the moment of notification practically removed from unfettered private disposal, and are subject to the design of roads to be afterwards determined. This means that an owner is prevented at once by the initiation of a town-planning scheme from hindering or spoiling the growth of a town by placing wretched houses or unsuitable buildings across the line of a public requirement, and then refusing to budge unless after fanciful or tyrannical compensation. The land being thus sterilised by the map for purely selfish interests, the laying out of the best roads will follow, and the purposes of the resulting sites will be defined.

Public-spirited folk should, therefore, at the very outset, before Map 1 is prepared or notified, interest themselves in securing a sufficiently wide outlook towards future development; growth should be anticipated, and no harm will be done by defining an imaginary belt or radius of open land at a certain distance from the suburbs up to which a town-planning scheme should ultimately extend. Provision should also

* The course consisted of four lectures, delivered on January 29th, February 5th, 12th, and 19th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into six parts.

be made for any new main routes in conjunction with the county and the neighbouring boroughs to which such roads would lead.

2. The owners of the lands included in Map 1, or other owners interested in neighbouring lands, may then object in writing to the proposal to prepare a scheme, setting out their reasons. A meeting is to be held, summoning by notice all concerned, at which the scheme shall be expounded and discussed; the objections that have been made are to be considered and, if possible, arranged at conferences—a course of action calculated to arouse local interest.

3. The local authority then by resolution will apply to the central authority—*i.e.* the Local Government Board—for leave to prepare a town-planning scheme dealing with the lands which are now to be shown on a second map—Map 2—giving every requisite description and reference to the lands, adjoining lands, existing buildings and interests, as well as the roads, widths and any proposed diversion of highways.

This Map 2 will reveal the purpose of the scheme and the general intention and direction of the main roads, but without details. If the proposal includes lands outside the district of the local authority the map must extend to five miles beyond.

A copy of all objections not disposed of has also to be sent up, and the estimated cost is to be proposed as nearly as possible. It may be pointed out that the cost of a scheme which at the outset might appear prohibitive tends by negotiation and conference between landowners and the promoters to diminish, if not entirely to vanish; for the advantage of having large areas of undeveloped land opened up by the public authority for building is so manifest that intelligent owners are often ready to give the land required for roads and public spaces, in order to secure the real betterment of development. The latent power to make and enforce a scheme is a sufficient preventitive of a dog-in-the-manger policy and of prohibitive prices.

Besides Map 2, the objections and estimate, particulars of acreage, population, rateable value and financial position as to loans have to be furnished, and notice of the application to the Local Government Board for permission to prepare a scheme has to be advertised.

Before granting permission to prepare a scheme, the Local Government Board generally holds a public inquiry, directed to the inclusion of lands and to any possible objections to the preparation of a scheme at all; naturally details are reserved. At this inquiry the objections made in writing can be enforced. It is quite probable that artistic or architectural matters concerned, such as the preservation of a beautiful view or an interesting ancient building, that may not have been afforded full consideration by the local magnates, can at this more judicial inquiry receive their due weight. The advantage of forestalling the expense of fully working out a scheme in detail is secured by this preliminary application for permission to prepare a scheme, as it involves the establishment of a *primâ facie* case for the proceeding.

4. The permission of the Local Government Board being given for the preparation of the town-planning scheme, with or without modification of its proposed extent, notice is to be given to all the interested parties, and any necessary explanation offered of the scheme. Architectural and archæological societies have a *locus standi* among interested parties, and can now make suggestions and representations that should be of value to the local officials. The preparation of the draft scheme follows.

The generation of the place is a matter of much public interest and of great public importance; for this the assistance of an expert adviser in town-planning design is certainly required. The combined wisdom of the borough engineer, surveyor, medical officer and town clerk will be mobilised, but neither one nor the other nor all ordinarily will possess the imagination based on experience, or the detachment from narrowing special interests, to make the best scheme. The civic architect will not disregard the local expert knowledge of essential factors—he will not be able to do without it; but he will supply the power to deal with and co-ordinate them to a satisfactory architectural end; for there is an architecture that deals with sites as well as for the buildings for which they are defined. This is as true of the ordinary constituents of the streets in a district as it is of the extraordinary purposes of the public buildings and squares.

The draft scheme is embodied in Map 4, accompanied by a statement of the required modifications of existing by-laws, the regulations for the classification of buildings, the appropriation of sites for shops and other purposes, the widths of roads, the limitations of heights and the number of houses per acre. The design will deal in all particulars with the future of the part of the town extended in a real and comprehensive fashion.

To have arrived at this stage of a town-extension plan prepared with a full consideration

of all the interests by a local community with co-operation and discussion at every step is a remarkable and significant achievement of civic statesmanship.

The draft scheme is then published for local inspection with all the requisites and Map 4. Objections, suggestions and modifications are to be publicly invited. These are to be made in writing; conferences will be held thereon, and a meeting held for explanation before the local authority finally by resolution forwards, a second time, the scheme to the Local Government Board for sanction.

5. Stage 5 is thus reached in the submission of the scheme, shown upon a new map, 5, sealed by the authority and containing all particulars, with the formal application and documents, together with a map, 6, of the whole district of the authority, and an ownership map, 7, accompanied by a copy of all objections that have not been removed or embodied in the scheme by conference, and finally, a detailed estimate of the contemplated expenditure and of estimated receipts so far as borne by or accruing to the local authority.

Public notice of the submission of the scheme to the Board is then made, so that objections "by persons affected including persons architectural or archæological societies or otherwise interested in the amenity of the scheme," may be addressed to the Local Government Board. The Board may then itself propose modifications and circulate a draft order of approval, to which objections are again invited.

The consideration of the scheme now approaches the final stage, and the Board will, if necessary, hold a further inquiry for discussion. The whole matter, with its various interests and developed importance, should by this time have become clear. Citizens will only have themselves to blame if the best use is not made of these ample legal opportunities for proposing, discussing and securing the embodiment of real improvements.

6. When the Local Government Board has decided to approve the scheme in its final shape, notice is published in the London and Edinburgh *Gazettes*, and the scheme in its entirety placed before the public. Any interested person or authority maintaining objections to its approval may then in writing set out the grounds of dissatisfaction. In this case, the draft of the order of approval is to be laid before both Houses of Parliament for thirty days, and if either House presents an address to the King against the draft or any part of it the whole scheme is dropped through this Parliamentary veto. This, however, will not prejudice the subsequent making of any new draft scheme.

The town plan when approved by the Local Government Board is an accomplished fact, enacted under part of the Housing and Town Planning Act, and may only be revoked or varied by a similar order and procedure.

This in outline describes the process by which towns may secure their environs and decide for themselves their future development. The ridiculous absurdities of unrestricted liberty and the evils of selfish thoughtlessness may thus be reduced or prevented by the definition of sites for different classes of buildings and by sterilising land required for main roads. After full investigation of a proposed scheme, adjustment of private interests with those of the community and consideration of suggestions for improvements, the beneficent tyranny of the State now compels the co-operation of the landed and building interests with their clients, customers or victims, by the local authority and the Local Government Board under the Housing and Town Planning Act.

A great reformation of the disorder surrounding our towns is now practicable with the powers thus created and granted, and should be everywhere attempted: suburbs may generally become interesting instead of unpleasant; sanitation, convenience and amenity should no longer be lacking. It remains for the practising architects, municipal surveyors and officers of health to adopt with enthusiasm this important machinery for civic progress in the exercise of their professions and for the fulfilment of their public ideals.

London Problems.

The Housing and Town Planning Act is in theory applicable to London, and the County Council is the town-planning authority for the metropolis; but within the area of Greater London are seventy or eighty authorities that would be more or less concerned with the preparation of any comprehensive scheme dealing with the problems that arise around the City, besides the equally urgent conditions that lie awaiting solution within the heart itself. It may be taken as proved that the County Council, as the central local authority, is unequal to the enormous task of generating and propounding a comprehensive plan of development that perforce must include a preponderating balance of interests outside its jurisdiction, or of improvement within which must involve the City area.

The subject of the application of town-planning to London cannot long remain in abeyance; it threatens to become another of those crowning anachronisms that the British lover of constitutional paradoxes accepts and suffers from the hands of a democratic government. At the root lies the still unsolved problem of the provision of a suitable central authority for the whole of London, clothed with ample authority to absorb and co-ordinate Imperial and municipal interests, and holding the executive and financial administration of all the elements central and circumferential to the capital. So long as the metropolis is dealt with as a city, a county and as an aggregation of municipal boroughs, and includes within its unbroken radius an increasing circuit of independent but integral towns, such as West Ham, Croydon or Willesden, with an annually growing tribe of urban districts and contiguous rural district councils, it will be impossible to foresee the solution of the volume of problems that goes by the name of London.

London has evaded solution through its size and complexity. As a whole, the puzzle is probably more full of interest and its solving of profit than that of any other capital city. Its age of over a thousand years of unbroken history, its extraordinary present vitality and world importance, and its unchallenged future as the capital of the Empire, while illustrating the difficulty of the scale, mark its urgent importance. It would be clearly vain to anticipate a reform of its plan such as Napoleon III. and Haussmann effected in Paris, though London is not disadvantageously placed either as to building materials or expansion. Its centralisation of world commerce, population, and Imperial Government are too involved and vital to endure the suspended animation necessary for a Parisian surgery of its arteries; the great bulk would faint if this were attempted.

It is not easy to sketch the problem as a whole. The main factor in the plan of London is the configuration of the river that determines the serpentine course of the routes corresponding to its direction. Laterally each arc in the loop of the course has its centre. St. Paul's Cathedral is situated on one; the Tower lies near another; Charing Cross is at the apex of one bend; and Waterloo lies near the heart of an opposite circle. The City is the real heart, historically and geographically as well as financially, always guarded by the Tower towards the east and by St. Paul's towards the west. The Government, Royal and Parliamentary, once extra-mural, is settled inwards at Westminster, and has drawn the wealthier residents around its parks; while the Port has drawn factories along the docks outwards down the river.

The growth of the City has been circular around the core, first by a circle of warehouses and small factories, now the outer city; next a once universal suburb of residences, but altering continually in use, as evidenced by Bloomsbury and Soho on the north, or by Lambeth and Walworth on the south; again encompassed by an extended area of factories and railway depots marking the approach of steam traction, as Paddington, King's Cross and Bricklayers' Arms; beyond is an ampler zone of residences, as at Holloway, Bayswater, Stoke Newington and Brixton. Rapid transit from the centre by railways and tramways then begins to fill up wide tracts of country on all sides, with a wide circumference of small houses laid out in what are called building estates; further off a new zone, partly occupied by larger factory sites, extending up to the distant hills and commons; and finally the undefined and increasing area of the residential properties of the civic aristocracy.

The main arteries are ancient highways, coach roads from the city to the provinces, their original purpose long superseded by the railways, and functionally without relation to developed zones of the whole city. The mediæval or original parochial boundaries, singly or in groups, almost stupidly crystallised, are made to serve the purpose of municipal, district or rural government, while the jurisdiction of the County Council applies only to what is but the intermediate zone between the heart of the City and the wider areas, where developing activity is conducted on rural or provincial methods.

The pressing difficulties of reform within and of controlled development without, and of traffic expansion that results in congestion at the centre, have constituted the main aspect of the problem of London for a generation. The puzzle is illustrated by the comparatively recent Royal Commission on London Traffic that was set up in 1903 and reported two years later. The Commission, which was strong in its membership and advised by a committee of engineers, offered practical recommendations upon its special reference as to traffic and designed a plan of new thoroughfares, and also proposed the setting up of a Traffic Board. But the recommendations of the report are to-day almost useless as a guide to the development or improvement of London traffic routes, as the problem has taken a fresh phase due to such trifles as the effect of the motor-omnibus upon tramcars,

or to the newly proved possibilities of tube railways.

A forward step was taken, though short and tentative, by the setting up of the London Traffic branch of the Board of Trade after the abortive report of the Royal Commission, by which valuable work was done in collecting data and in studying the development of the arterial road system of the metropolis. The Local Government Board organised conferences of all the local authorities in and around London in large district groups, the results of which have been co-ordinated in a great map prepared by the London Traffic branch of the Board of Trade. The value of this already attained result is but little known outside the circle of these conferences, and public attention must be called to it. It is greatly to be deplored that this highly useful department was suspended in June, 1916. This is a war frugality bad both in policy and economy, for the department was conducted at small cost—it is a shortsighted step likely to prove highly extravagant and retrograde. The revival of this small and efficient advisory and informative department, which had no spending powers, must be urgently demanded in order to continue work tending to palliate evils attending the distending growth of the body of London. The reports of the Arterial Road Conferences and the Traffic branch map, however, actually exist, though liable to the rapid decay that sets in upon the laying up of plans.

This Gordian knot of town-planning is, however, stimulating endeavour. The London Society embraces numbers of workers in different spheres united in their interest in the problems of civic improvement and development. Since the outbreak of war the society has undertaken the preparation of a comprehensive survey of London and its environs at a cost of about £1,000. As a graphic statement of most of the facts essential to a grasp of the great town-planning scheme that should eventuate, the survey is a fine endeavour to do the groundwork of recording existing factors of population density, of employment, of residential and commercial districts, of traffic and amenity. This has now been carried through to completion and is available, together with the Arterial Road map, providing materials, for an immediate consideration of the much overdue scheme for the comprehensive improvement and development of London by a town-planning authority, yet to be created by Parliament, for the whole area.

London during the nineteenth century passed through several eras of improvement, at first designed and carried out by able architects fulfilling the traditions of the school of classic architecture prevailing on the Continent. The Gothic revival disturbed these ideals fundamentally, and, discrediting symmetrical repetition and horizontalism in formal design, delighted in the romantic quaintness of crooked streets and accidental picturesqueness. The effect of this rebellion upon civic architecture was that the conduct of street improvement became a mere matter of solving traffic problems by the aid of engineers. The decay of the Gothic movement is even yet scarcely completed, for its artificial romanticism still infects the profession of architecture with bygone ideals and reactions labelled successively Elizabethan, Jacobean and Georgian. The progressive expansion of the Victorian era, thus left without any natural or spontaneous architecture, found guidance only in utilitarian motives, and to-day we are wrestling, it is to be hoped not vainly, to infuse a new and vital orderliness, culminating in beauty, upon the practical spirit that has for so long a time dominated municipal improvements.

On the conclusion of the European Napoleonic wars, so similar in their area to the present struggle, the far-sighted and highly successful improvement of the West End of London was undertaken. St. James's Park was linked to Marylebone Fields—practically the whole western frontier of London—by means of Waterloo Place, the Quadrant and Regent Street, culminating in the laying-out of Regent's Park. In the City, a little later, two great thoroughfares, King William and Moorgate Streets, concentrating at the Bank, were courageously planned and designed with harmonious elevations. The next generation witnesses an altering ideal. Cannon Street—a most convenient thoroughfare, that relieved much confusion, had no architectural motive, its junction with St. Paul's being accidental, and the street elevations that possessed a respectability of type were soon discredited by the ancient Gothic taste. The Holborn Viaduct is another radical improvement of great value to traffic, carried through as a work of engineering without architectural inspiration, though the contemporary Smithfield Markets show that the City Corporation could have done better if it had wished. Other Victorian improvements, in the formation of new streets through crowded areas for needed traffic facility, in the City and Westminster, bearing the Queen's name, are in the same category of usefulness with unsatisfactory results: each

street manifests the loss of amenity, as well as of real interest and value, resulting from the neglect of the artistic consideration of its effect.

The Thames Embankment, however, remains a worthy monument of a great era, even though its great architectural merit is not generally recognised and its inspiring genius remains unknown. The work of the reclamation of the foreshore from Blackfriars to Westminster was undertaken by the Metropolitan Board of Works in order to provide a new traffic route. It has bestowed upon the capital a new and unique charm of great scale and importance. The fine concave line of the river is marked and emphasised by the severe and entirely unaffected strength of the wall; the marvellous effect of harmonising the diversity of buildings and elements that its great causeway achieves between St. Paul's at one end and Westminster at the other creates an impression of London that is singularly restful and complete. The group composed by Somerset House with Waterloo Bridge and the Embankment works is a contribution to European civic architecture probably embodying more of a vision of Piranesi than can elsewhere be found in actual existence.

Subsequent improvements promoted by the Metropolitan Board of Works seem to indicate that the architectural beauty of the Embankment was accidental and unperceived. Northumberland Avenue, in itself a satisfactory thoroughfare, has no architectural relation to Trafalgar Square and the Nelson Column; the angle of its connection with the Embankment quite wrongly disregards the direction of the river, and confines the vision to the eyesore of the railway bridge, The same ignorance of the relation of street design to architecture is displayed in Shaftesbury Avenue, and the mutilation of the ingenious and dignified arrangement of Piccadilly Circus was an irreparable outrage. Soon afterwards the Board of Works ceased to exist, though not on the ground of the architectural failure of its methods of street improvement.

The London County Council, the succeeding authority, undertook the Holborn to the Strand improvement. The scheme was mooted on a sufficient scale, but it was only upon the exercise of considerable pressure that the picturesque churches in the Strand were retained and embodied in the plan and their extraordinary value in the civic landscape admitted. This improvement has been brought nearer to success than any recent London improvement on a great scale, but it has failed of proper architectural result through lack of courage in proposing from the commencement and maintaining any artistic idea. The difficult question is raised of the propriety and economic possibility of prescribing a general uniformity of style in the elevations such as met with success in Regent Street. But public opinion at the commencement of the century was more docile, or better educated, than at the close, and the County Council, concerned with finding tenants for the new sites, hesitated to impose restrictions on the design of the buildings—a concession that after more than twenty years' delay has not availed to complete the scheme. The delay in the Strand portion, however, still affords an opportunity for obtaining a fine frontage treatment.

These contemporary schemes are unfortunately and needlessly characterised by the neglect of civic architecture: the absence of any motives more inspiring than the accommodation of variable traffic or the temporary balancing of betterment has doomed these considerable undertakings to the limited purposes of convenience and the service of a false economy. Improvement itself becomes a doubtful term in the absence of an ideal appealing to the imagination and ministering to a reasonable civic pride. The Londoner could only dubiously claim the historic and highly authenticated right of boasting that he is "a citizen of no mean city." This opportunity has been sacrificed through this melancholy neglect of architecture in civic undertakings, leaving him without inspiration or any idea that civic improvement may be intellectual as well as sordidly utilitarian.

A few of the current and urgent problems of civic architecture in London will illustrate the general interest of the subject and its claims upon public attention, and their mention may, perhaps, direct attention to opportunities for consideration and action, both by authority and by that private munificence which a great city conscious of the possibilities of architecture generates within herself.

In the sphere of Government action the Royal domain exhibits a partially executed improvement in the historic playground of The Mall, where are yet unmeaning features that indicate the beginning rather than the completion of concentrating avenues to the north of the Victoria Monument and opposite Marlborough House. The entrance from Trafalgar Square is a confession of failure that is intolerable.

Imperially, the provision of a chamber for the Supreme Council of the Empire is a real want that does not appear to have occurred to anyone of importance. The significant gathering of the

new Imperial Conference, the historic importance of which cannot be overlooked, meets in temporary buildings behind the undignified official tabernacle of the Prime Minister in a side street. Self-respect demands a suitable and convenient chamber for the Empire Council that is permanent and not makeshift, and that will offer an elevating rather than a depressing token of actual power. Common sense and our fundamental confidence in the permanence of the British State, and not architectural sentiment only, protest the importance of this matter in demanding the explicit symbol of a worthy home in the capital for the great Council of the Empire.

The fortuitous growth of our departments of Government may be the cause of our almost entire want of foresight in the provision of office buildings for the State; but nearly three centuries ago the great palace designed by Inigo Jones for Charles I. was designed to concentrate, in conjunction with the residence of the monarch, accommodation sufficient for all the officers of State in convenient proximity to Westminster. The principle of the Assyrian palace of the city, carried out with the dignity of the greatest Roman forum, is embodied in this design for what would have been the largest palace building in the world. To-day the heterogeneous permanent Government buildings straggle over but parts of the area included in the Royal plan, which had fronts at Charing Cross and Westminster and flanks to the river and park, for the scheme was for three quadrangles on each side of a great central thoroughfare court the full length of Whitehall. The dignity of such a plan was partly revived by Sir Charles Barry's design for Government buildings on the western half of this site facing the park, but only to be laid aside for foolishly partial expedients. It is futile for us to deplore the short-sight of our fathers when we consider the increasing blindness of our own generation. Timidity and panic have characterised the expansion of offices necessitated by the war. It is deplorable to contemplate the want of practical wisdom and the resulting waste of money and effort that, rather than complete the more than half erected County Hall, the largest office building in the country, or the ferro-concrete Science Museum at South Kensington, which is well in hand, spent large sums in wasteful temporary buildings and in expropriating expensive hotels and clubs. It should require no argument to convince the nation of the necessity of setting up a new and authoritative Ministry of Public Works, competently advised, without delay.

In the sphere of the commercial life of London the provision of new and wide thoroughfares from the docks has great urgency; no public works would be more practically economical in effect or more directly further the despatch of the business of transport. The conditions in the vital traffic arteries along the northern bank of the river towards and between the docks almost pass description. A calculation of the avoidable loss of time to transport arising from the congestion in the narrow, indirect thoroughfares held up by dock bridges, and also a consideration of the inane failure to deal with the roots of the problem, would provide a wicked fairy with a tale fit for German dreams. The London Traffic branch of the Board of Trade and the Arterial Roads Conference are well aware of this damaging state of affairs, but are as helpless as the rest of us in the presence of the complication of local with national interests. The Silvertown explosion, releasing a large area for rebuilding, has not even awakened the powers that be from their slumber to this unexpected opportunity for doing something drastically useful. The formation of new and wide streets in the neighbourhood of the Port should also remind the authority that a wider area for improved housing with amenities near the docks and warehouses would heal and obviate social complaints that have been unduly tolerated.

The municipal architecture of London will owe not a little to the courage that has selected a magnificent and ample site on the Surrey side for the new County Hall; but the failure must be recognised, in connection with this notable centralisation, of hesitating to plan the development of the southern shore of the river from St. Thomas's Hospital to St. Mary's Overie, Southwark. Contentment is not possible with small instalments of architectural improvements that necessarily create urgent demands for the neighbourhood in which they are planted. The London Society has already obtained expert advice in preparing schemes for discussion and in assistance of public opinion on this surprisingly neglected area so near the real centre of the metropolis. To that district and subject belongs a not inconsiderable part of the urgency and value of a new public bridge at Charing Cross, though this has perhaps its greatest claim in the need for opening a thoroughfare from Trafalgar Square southwards to release the streams which flow from the north-east and west districts. The great sin, both artistic in its architectural brutality and obstructive to

public convenience, of the makeshift railway bridge must cease to be perpetuated, for it effectually prevents a vitalising improvement.

The bridge problems of London naturally affect both sides of the river, and cannot be undertaken apart from well-planned access and the development of the surrounding areas. Hence the St. Paul's Bridge, promoted by the City Corporation, besides its stupid ignoring of the architectural opportunity of relation to the greatest monument in the kingdom, is doomed to failure by the absence of corresponding routes of adequate scale giving access to it through the City and Southwark, the former almost impossible of achievement and the latter at present undesigned. The provision of a bridge at the Temple, where access from Kingsway and the eastern horn of the Aldwych crescent has already been made, is a more patent requirement: this scheme should follow on the construction of the new bridge at Charing Cross, and thus open up the centre of the southern curve of the river to that share of the life of the city that its situation renders so possible. The concentration of the termini of the southern railways on the Surrey side is involved, and will prove economical and remunerative to the companies and public; while the utilisation of the three existing tubes beneath the river will provide for the daily workers, and indicate the direction of extended accommodation, demanded but impossible of achievement above ground.

Another problem ripe for solution is the extension of a western highway from Cromwell Road, South Kensington, where a great length exists of ample width. It is difficult for the man in the street, whether afoot or in a motor, to understand why, considering that half the cost of this improvement was proffered by the Road Board five years ago, it has not ere yet been set on foot by the London County Council.

A final selection must be made from among many interesting and promising schemes of an artistic nature. Of these the most urgent is the provision of first-rate places for national memorials, which lose so largely in their impressiveness if not placed on the best possible and most obvious sites. The story of the London monuments has long provided matter for sad humour; but there should be no need for the continuance of this melancholy pursuit. Historical critics will undoubtedly justify both the Albert and Queen Victoria Memorials as great and characteristic works, representative of the taste and achievement of their respective epochs, and as occupying ample and suitable sites. But we cannot forget the trouble and indecision about the as yet unerected monument to King Edward VII., finally and happily decided to be set up in Waterloo Place. We hold both breath and speech, however, at the costly rearrangement of the Crimean memorial and the ludicrous pavement plan so serenely approved around this and the statues of Lord Herbert and Florence Nightingale.

A unique site is demanded for a memorial to Lord Kitchener in as great a place as any in London for the hero who saved his nation. The union in sacrifice, strength and victory of the Allies will crave a great peace memorial that will not merely be utilitarian and selfish in purpose, besides the scores of heroes of the Navy and Army whose remembrance will be a necessary element in national education by eloquent and ennobling monuments. Sites for all these remembrancers are as important as the character of the erections upon them. We ask, for stimulus of thought and idea more than for information, if they have yet been taken into consideration by the Government, on behalf of the Nation, to whom the duty belongs? and if a committee should not be forthwith set up to give this inevitable subject proper forethought and preparation, for the time is at hand for execution? Our interest in the subject of civic art will find in this solemn but happy celebration of our national epic by great monuments upon the noblest sites a practical and imaginative sphere of operation that will not only honour our heroes but our hearts.

Civic architecture and town-planning has proved a subject wide and varied as human history and fancy. This partial and imperfect review has opened aspects of great attractiveness and practical usefulness; the study and furtherance of this subject as a means of intellectual expression and of social beneficence should be pursued and given effect to, whether in the capital, provinces or overseas, for the sake of our great inheritance and of our greater future.

SISAL.

The price of this product is likely to rule high in the future, and the success of Germany in East Africa should stimulate exertions in our territories. It is said that no failure of a crop has ever been heard of on suitable land. Provided the soil is rich in lime and not swampy, poor and gravelly lands are very suitable, and therefore estates which have been worn out by sugar and such other crops will give good yields. The reason of the advantage of poor soils is that the life of

the plant is much longer, running to ten to fifteen years.

The *Queensland Agricultural Journal* advises that the plants to form a plantation should not be higher than 10 or 12 in., or even less. Older plants take a much longer time to start growing. When planting, all dry leaves at the base of the young plant should be taken off as in the case of pineapples, and the main roots cut off and pared as closely to the trunk as possible. They must be planted perpendicularly, and only the lower portion of the trunk must be covered. The distance apart in the field is a question of soil. In rich soil the rows may be 10 ft. apart, and the plants at intervals of 6 or 7 ft. In poor ground 8 ft. by 6 ft. is as close as the plants should be set. Roadways should be left at intervals of five chains.

Once a field is planted, it may be practically left to itself, as there is probably no crop, except the castor-oil plant, which requires less care to bring it to perfection than sisal. At the same time, a little care is needed at the outset until the plants are robust. No weeds should be allowed to grow, nor any to overtop the sisal plants, as they require all possible light, air, and sun. Tall weeds may be mown down.

In about twelve months suckers will begin to appear, and in twenty-four months these will be produced at the rate of 100 per plant. These must all be removed for two reasons. One is that they deprive the mother plant of the nutriment it requires to produce large leaves and plentiful fibre. The other is that the suckers are valuable either for extending the area under sisal or for sale to intending planters. To plant up 100 acres 60,000 to 100,000 suckers are needed.

The life of the sisal plant is intimately connected with the production of the flower-stalk, technically called the "pole." The life of the agave (sisal plant) is a comparatively long one, but the long life may be materially shortened by injudicious management. The sign of the termination of its existence is the sending up of the pole. This happens when the plant arrives at the cutting stage and the leaves are left uncut. It may also be the result of over-cutting. Much judgment is required, therefore, to ensure that no pole shall appear for ten, twelve, or fifteen years. When the pole has appeared, it should be notched and bent over as soon as it appears, in order that all the leaves on the plant should be ripened before it dies. In this way the plant is kept available for yielding fibre a year later than it otherwise would be. Immature leaves should not be cut. As a general rule, the ripening leaves gradually fall from the erect to the horizontal position on the plant. Then are the leaves to be cut. It should not be lost sight of that when a mature plant sends up its pole all its suckers at once follow suit and send up slender poles. Hence suckers from a poled plant should never be used in forming a plantation, as it will probably not be six months before the pole appears.

According to conditions of climate, soil, and the kind of plant, the first leaves will mature in from three to four years. For harvesting the leaves, account must be taken of their length and state of ripeness. The length of the fibre is one important factor in its fitness for the market. The least length admissible is 2 ft. 6 in., and every additional length increases its value. It is not advisable, however, to cut leaves until they have attained a length of 3 ft. These leaves will average about 3 lb. in weight, but they frequently attain a weight in the Brisbane district of from 5 lb. to 7 lb. If left long after the leaf has reached the horizontal position—*i.e.* at right angles to the trunk—the leaf droops to the ground, acquires yellow spots, and, when machined, much of the fibre is broken off short at these spots, and is only saleable as tow. The unripe leaves produce a brilliantly white fibre, but these, as stated, must not be cut. The number of ripe leaves per plant when from three to four years old will vary from ten to twenty, according to conditions of planting, rising in subsequent years to forty or fifty. This does not mean that forty or fifty leaves are at once cut from each plant, but it refers to the aggregate of the year's operations. The leaves are cut with a curved knife. Proper cutting consists in cutting the leaves as close as possible to the trunk. Loose cutting results in a considerable loss of the strongest part of the fibre. If 3 in. of each forty leaves are left on the plant there is a loss of 10 ft. on each plant, or 10,000 ft. on an acre. This is a matter well worthy of attention by sisal planters. One man should cut and tie up an average of 1,200 leaves a day.

As to yield of fibre, on average poor soils, plants 7 ft. by 8 ft. (799 to the acre), 7 lb. of fibre per plant, or 5,630 lb. per acre, is obtainable; but it is well to reckon on only 15 cwt. or 1 ton of marketable fibre per acre. One ton of sisal fibre is worth, in England, from £55 to £60 per ton. Once the plants have arrived at the cutting stage, no other labour is required in the field except the cutters and carters.

Machining is performed as soon as possible after the leaves are cut, as, if two or three days elapse, the fibre will be spotted and consequently of reduced value. The fibre is extracted by various machines, cheap and expensive, but all work by means of drums and beaters, which, as the leaves are passed in, beat off in one action the whole of the fleshy part of the leaves, leaving the fibre, except for drying, practically ready for market. The cheapest machines cost about £40, and require a two-horse-power oil-engine. They are made by J. Wilson, engineer, Elizabeth Street, Brisbane. Other machines are made in Manchester, costing before the war about £75 and upwards. The American automatic machines, in which the leaves are laid on a carrier side by side, and pass continuously into the machine, coming out as pure fibre as fast as the leaves can be fed, cost from £400 up to £1,000, and will clean from 70,000 to

150,000 leaves daily. These require from 20 to 45-horse-power engines. The capacity of the Wilson machine is about 160 lb. of fibre per day.

Finally, there is no particular time for harvesting sisal leaves. The work may go on all the year round. One thing should be attended to—when the plants have been cut once, a sucker should be allowed to grow up near the parent plant, so that when the latter dies the new plant will have arrived at the cutting stage, thus avoiding the replanting of the field.—*The Colonial Journal.*

CANADIAN LUMBER.*

In the list of Canada's natural resources agricultural field crops hold first place in value of production with an estimated total of from $700,000,000 to $800,000,000 annually; forest products come second, with a total of about $175,000,000 for the primary products, and this figure is considerably increased if paper and other manufactured products are included. In 1916 the exports of products from wood amounted to approximately $100,000,000, not including the minor proportion of specially manufactured wood articles, showing the place which our forest resources will take in helping to overcome the war debt. According to the census of 1911, the capital invested in timber and re-manufactures amounted to $259,889,715 in 4,999 establishments, this being the highest figure on the list. In addition, the paper and printing trades accounted for an invested capital of $62,677,612 in 773 establishments.

By far the most important and extensive utilisation of wood consists in the manufacture of lumber and other products by mechanical processes, whereby the wood still retains its identity.

Under the heading of wood used in the rough, firewood takes first place, and in value accounts for about 30 per cent. of the primary wood products. Air-dry wood has a calorific value rather more than half that of coal, pound for pound. The annual normal consumption of railway cross-ties in Canada is about 20,000,000, with an average value of about 45 cents each. In order of importance the Canadian tie woods are jack pine, eastern cedar, Douglas fir, hemlock, tamarack, western larch, and small quantities of other species. Hardwoods such as birch and maple are now coming into use, as creosote treatment successfully overcomes the low durability of hardwoods, and the ties have the advantage of high mechanical strength.

The annual consumption of round mine timber is over 53 million linear feet, with a total value of $524,000, while the mines consume sawn timber to the extent of 23 million feet board measure, valued at about $304,000. About 140 coal and ore mines in Canada use timber, the leading woods being Douglas fir, spruce, balsam fir, lodgepole pine, jack pine, and hemlock. Spruce and other piling is used quite extensively in Canada, and forms an important export item.

The term "lumber" is used to include a wide range of material, and constitutes the most important manufactured product. A large proportion goes directly from the saw-mill into general building and construction without passing through an intermediate wood-working factory. In 1915 the lumber cut in 3,239 mills totalled 3,842,676,000 ft. board measure, with a total value of $61,919,806, which includes a good deal of structural timbers.* The term "structural timbers" covers wood so used that its strength is a factor of first importance, and includes timbers for mill construction, trestle and bridge timbers, wharf timbers, larger ship timbers, etc. The Canadian species in order of merit and resources are Douglas fir, western hemlock, eastern hemlock, western yellow pine, western larch, red pine, and eastern larch. Douglas fir † is fully equal to southern longleaf pine as a heavy structural timber, and, with the tremendous untouched resources in British Columbia, is destined to become Canada's most important tree.

The rough manufactured products are too well known to require discussion.

Wood flour, or wood meal, is the fine, fluffy, absorbing fibre made by grinding wood chips in a stone mill or steel burr roller mill with a limited amount of water. It is used in the manufacture of dynamite, inlaid linoleum, oatmeal wallpaper, and wood plastics. Canada imports considerable quantities from Europe and the United States chiefly for the manufacture of dynamite, and there is no reason why the industry should not be established in Canada for both local and export trade. Wood wool is a fine excelsior, used in Europe for surgical dressings, filtering, stuffing mattresses, and as a substitute for cotton waste.

Specially manufactured products include hundreds of different kinds of articles wholly or partly constructed of wood. In Canada this group probably accounts for 15 per cent. of the total wood cut. An economic principle underlying the proper use of wood is that each species of wood has a legitimate field of usefulness within which it should be employed. Custom, prejudice, and lack of information frequently prevent the use of a species for some purpose for which it is naturally adapted. A large amount of accurate data still remains to be established, and there is a wide field for technical research in determining the mechanical, physical, and chemical characteristics of Canadian woods.

Special mention should be made of the by-products of the lumber industry, since they constitute an enormous amount of wood material

* Extracted from an article on "Present and Possible Products from Canadian Woods," by John S. Bates, A.M., Can.Soc.C.E. (Superintendent, Forest Products Laboratories of Canada), in the *Pulp and Paper Magazine* of Canada.

* The recently published Forestry Branch Bulletin No. 59, "Canadian Woods for Structural Timbers," covers this subject in detail.

† Forestry Branch Bulletin No. 60, now in the press, gives a detailed account of tests made on Douglas fir at the Forest Products Laboratories of Canada.

which for the most part is now going to waste. Utilisation is retarded in Canada on account of the scattered population and limited markets as well as the technical nature of many of the processes. It is estimated that the logging waste which is left in the woods represents about 25 per cent. of the original tree. Obviously the opportunities for utilisation are limited, and the main problem in Canada at present is rigidly to enforce the proper burning of slash in the wet seasons to remove this serious fire hazard and leave the woods in better condition for second growth. Other losses in the forest are due to fire, insects, fungi, wind, thick growth, scattered growth, local predominance of inferior species, mature trees not up to cutting standard, inaccessible timber and land-clearing operations. These are some of the problems which confront the forester, and the importance of the forest protective movement is emphasised when we remember that forest fires in Canada have destroyed perhaps ten times as much wood as has been taken out by the lumbermen. The federal and provincial forestry branches and the various associations have done a great deal to safeguard our widespread forest resources and to secure the co-operation of the public in overcoming carelessness in the woods.

Saw-mill waste amounts to about 40 per cent. of the original tree, so that the finished lumber on the average represents from 30 to 35 per cent. of the tree. New developments in the utilisation of wood waste are being made continually, but it is false economy to handle waste unless the by-product industries can be carried on at a profit. Effective utilisation calls for a variety of chemical and mechanical processes, which must be adapted to the form, species, and quantity of wood waste available at any point. Slabs, edgings, and trimmings represent 15 to 17 per cent. of the tree. Among the more common uses are fuel, laths, box shooks, small slack, cooperage, small wooden articles, kraft and sulphite pulp, excelsior, wood flour, wood wool, and producer gas. Sawdust accounts for another 11 per cent., and is used to some extent for fuel, producer gas, briquettes, polishing metals, insulating, packing, bedding in stables, floor-sweeping compounds, composition flooring blocks, linoleums, improving clay soils, smoking meat and fish, blasting powders, wood flour, plastics, porous bricks, mixing with mortar and concrete, distillation, ethyl alcohol, oxalic acid and carborundum. Bark amounts to about 10 per cent. of the tree. It is usually used as fuel, although hemlock and oak barks are important in the tanning industry. A recent development is the use of spent hemlock bark for mixing, to the extent of about 30 per cent., with rag stock in the manufacture of roofing felts. Experiments on its use in wall board, indurated pails, conduits, and wall paper give promises of success. In the manufacture of special wood products a good deal of wood is lost during seasoning by decay, due to poor methods of storage, and also by warping and splitting. There is a large waste in converting wood into desired shape for the finished article. Proper co-ordination with plants making small wooden articles brings about a great economy of material. Shavings find use as fuel and to some extent for packing, bedding, drying wet land, and manufacturing fibre board. Beechwood shavings are required in large quantity by vinegar factories; but this is another case where specially cut wood is usually used instead of relying on by-product wood from various plants.

SOME INDUSTRIAL DEVELOPMENTS IN JAPAN.

Writing in the first issue of a new periodical, *Chemical Technology*, Professor H. Nishida describes some recent developments in Japanese industries. He states that in regard to the manufacture of dyes many plants have been established since the outbreak of the war, in the endeavour to produce the 12,000,000 lb. of dyes required in Japan annually, but most of them have had to close owing to shortage of capital and lack of expert assistance. The Japan Dyestuff Manufacturing Company, which is subsidised by the Government, has for some time past been working successfully, producing aniline oil and salt, phenol, Orange II., Benzo Purpurine 4B, Fast Red A, and Congo Red. A number of direct, basic, and sulphur colours will shortly be produced, and it is also intended to manufacture synthetic indigo. The Tokyo Gas Company and the Mitsui Mining Company have also met with considerable success, and are producing dyes on an industrial scale.

The manufacture of medicinal chemicals has also received a great deal of attention, and a number of compounds are being produced for the first time in Japan, including morphine hydrochloride, salicylic acid, bismuth compounds, atropine sulphate, chloroform, codeine, guaiacol, heroin, and tannin.

The wood distillation industry received a great impetus owing to the increased prices. Acetic acid manufacture had already been placed on a sound basis, and the works were able to extend their output to such an extent that they produced over 3,450,000 lb. in 1915, of which nearly 1,470,000 lb. were exported. Importations of calcium acetate from America having ceased during 1915, the manufacture of this product in Japan has increased considerably. Imports of formaldehyde into Japan amount normally to about 1,000,000 lb. annually, mostly from America and Germany; these supplies are not now available, and steps are being taken to manufacture sufficient to fill the local demands at any rate. The output of methyl alcohol has also been increased, and the process of making it improved. Formerly only about 300,000 lb. were produced annually.

The consumption of glycerine in Japan amounts to about 1,700 tons per annum, of which 1,000 tons were imported, mainly from England,

America, and Germany; several plants, one of them working under Government subsidy, have recently been erected, and it is expected that the supply will shortly meet the demand.

Japanese glass manufacturers have been doing greatly increased business, especially with India and Australia. The over-production which took place in the celluloid industry prior to the war has resulted in one of the manufacturing companies abandoning the production of celluloid and turning to the manufacture of nitrocellulose for military purposes; owing to the cessation of imports of celluloid from Germany, the recent supply has scarcely been adequate. A large expansion has also resulted in the paper-making industry, consequent on the cutting off of imports; production during 1915 is stated to have amounted to 210,000 tons. Filter paper is now being manufactured in Japan. The difficulties experienced in obtaining an adequate supply of sulphite pulp are being overcome, and shortly Japan will be independent for raw materials for paper.

Prior to the war, phosphorus was imported into Japan to the extent of 70,000 lb. annually; only two Japanese factories produced it, and their output was about 12,000 lb. The rise in prices following the outbreak of war caused a greatly increased production, which is now about 37,000 lb. annually, and is being enlarged rapidly. Potassium chlorate is another substance of which the greater part (3,000 tons out of 4,000 required) was formerly imported.

EXTRACTING OIL FROM FILBERTS.

Although Trebizond has always been considered more important agriculturally than industrially, the stern law of necessity has given rise to a new enterprise which, if carefully developed, may be a factor in the future commercial activity of this region and the beginning of an industrial life there. Soon after the outbreak of the European War kerosene and olive oil advanced in price so rapidly that they proved beyond the reach of a great part of the population. According to a report by the United States Consul lately at Trebizond, some of the inhabitants there, in looking for a substitute, tried crushing filberts, which the cutting off of export facilities had left on their hands in large quantities. This experiment, confined at first to individual homes, proved successful, and before long several of the leading inhabitants went into the business on a larger scale, taking it from the houses to small factories. The oil was used for cooking and lighting purposes, and also in the making of soap.

Although the largest of the factories has been destroyed by fire, there are three others in operation, and the industry is still carried on in twenty or twenty-five private homes. In the factories the nuts are first shelled and then usually fried or roasted, after which they are put in a heavy press. The oil is poured into a large vat, boiled slightly, and then forced through a heavy cloth, which acts as a strainer. This completes the process. In the "home" industry the nuts are not roasted, but after being shelled are dipped in hot water and then pressed. The result is that the oil has much less taste of the nuts and is consequently of a superior quality; but as the oil is not boiled at all it cannot be kept for long periods, especially in the summer. By roasting the nuts before pressing large quantities of oil can be obtained. The present proportion is 1 lb. of oil for 6 lb. of nuts. The residual product is sometimes used as food for animals, but is more often sold to the peasants, who prepare it in various ways.

The industry is, of course, in an elementary stage, the total weekly capacity being only 7,200 to 7,500 lb. In each "shop" there are not more than fifteen workmen. Except for the shellers the machinery is quite primitive, most of it having been made by hand in Trebizond. More up-to-date machinery might be profitably installed after the war if it is seen that the competition of olive oil can be met. The interesting and significant fact, however, is that the initial efforts have been successful. The people are learning that industrial initiative can have profitable results.

ARTS AND CRAFTS.

Autumn Printed Fabrics.—The autumn is always the time when a certain amount of renovation has to be done in the home, and so, though we do not at this season of the year have such a quantity of new design and of new ideas let loose upon us as in the spring, we do find that the decorators and furnishers are making a special effort to show something which will strike their customers as in some measure fresh. The colour schemes displayed in the windows and the show-rooms of the large firms must be regarded as an index, if not to the popular taste of the moment, at least to what passes for it. Public taste is, however, never easy to arrive at: what we have as a rule to be content to regard as the taste of the great mass of our fellow countrymen is really, in the main, that of the middleman and the shopman, who have unrivalled opportunities for imposing their own likes and dislikes upon their customers. Of course, nowadays, there are comparatively few new patterns; but the very cause which has led to conservatism in design has encouraged new departures in colour. This is very marked in the case of decorative fabrics of all kinds. It is obvious that the prevailing tones of colour are not just what manufacturers and designers would have chosen had they been in no way hampered by difficulties of production, or had it been as easy as in pre-war days to secure a large range of bright tints which could be guaranteed permanent; but for all that, the present colourings are deliberately chosen and are by no means entirely due to necessity. At present a few of the most up-to-

date firms are showing printed cottons and linens in which the brightest colours seem to be trying to see how closely they can jostle one another; but these bright stuffs are very often used in conjunction with black furniture, or the bright tints are printed upon black or very dark grounds. The black, of course, only heightens the effect of the colours which are upon it, or to which it serves as frame or background; but, nevertheless, the impression left on the mind by a room decorated in bright colours and black is on the whole a dark rather than a bright one. It may, perhaps, be inspiriting to certain people, but to many of us it brings a feeling of depression and almost of oppression. A bedroom in such colours suggests at once not repose, but dreams of a rather unpleasant and almost unwholesome character. This type of colour plan is, however, only to be found in certain places which cater for people of pronouncedly modern tastes. More often the autumn materials for hangings, curtains, and covers are characterised by a certain drabness and dullness. There are very few pure bright colours, and cotton and linen materials which look as if they were, at any rate at some time in their production, fresh in colour, have often been toned down, either by having been printed in the warp, or by having lines or small patterns in neutral tints superimposed. There is, however, plenty of colour about which, though by no means bright, is in its sombre way exceedingly rich. Good use is often made of deep purples and orange and other strong colours. Another distinguishing feature of the present printed furnishing fabrics is the absence in most of them of any definite outline. It seems as though the strongly coloured, rather brutally cut designs, which came to us originally from Austria or South Germany, have in this way left their mark upon our own work. A good many of the designs are rather incoherent, and in those which are not, the printing is often so arranged as to produce the impression that the effect (which has really been very carefully thought out) has been reached quite by chance. It is, perhaps, just worth noting that the modern tendencies are beginning to be felt in connection with such things as bedspreads and quilts, which are usually rather in the rear than in the forefront of fashion. It is now quite the exception to find a quilt which is all of one plain colour. The upper side at least is generally partly or wholly covered with a small, rather gay all-over pattern which is sometimes, though not usually, quite coarsely printed. The colouring is generally fairly fresh, but it is evidently occasionally based on the assumption that the bedstead will be black and the general surroundings such that a quilt of a deep rich colour will be in keeping with them.

Lampshades and Light Obscurers.—The shortening of the days and the necessity for obscuring, or at least shading, all lights at an earlier hour, has brought to the fore again the question of shades, not only for candles and lamps, but also for gas and electric light. Lampshades do not last for ever, and people are busily renewing them for the approaching winter. The shades upon the market may be roughly divided into two classes—those which fulfil the function usually assigned to such things before the war of diffusing the light pleasantly and looking pretty on the table or about the room, and those which are meant primarily to shade lights on stairs or in passages, halls, and other places in order to comply with the lighting regulations. In the first class there are naturally, in the usual course, all sorts of new developments every year. Perhaps the most notable feature about present-day shades which come under this category is their comparative simplicity. The fussy frilled creations once so popular seem to be things of the past, and the more elaborate shades are nowadays distinguished by their colouring or the fact that they are daintily hand-made and hand-coloured. Even those which are less severely simple than their neighbours are made with beads, which, since they can easily be cleaned, are a most sensible form of decoration for such a purpose. Diaphanous fabrics elaborately frilled and tucked offer endless opportunities for the dust to lodge. Of late the tendency, in the case of smaller lights, has been towards pieces of thin material, often painted or printed in many colours, so arranged as to look as though they had just been thrown over the light, and these are kept in place by beads or some other heavy trimming at the edge. In the second class there appears to have been far less enterprise than one might have expected. The lantern-like protections with silver or brown (or, unfortunately, more often grained) cardboard frames and green panels at the sides answer their purpose quite well, and they might be much uglier, but they are not things of beauty, nor are they peculiarly fit for private houses. The thick paper shades moulded in imitation of quilled silk leave a good deal to be desired. The supply of four-sided Japanese shades, in which stiff paper cut into various patterns (rather after the fashion of a stencil plate) is placed over a plain background of some dark colour, seems to be running short. These shades were put upon the market last year, and it is no longer so easy to import such things. There are, indeed, some European stiff paper shades to be had decorated in Chinese or Japanese patterns, with little holes cut out and covered in with thin paper, which lets the light shine through to represent the sun or lanterns or some other kind of light; but it really seems surprising that more has not been done in this direction on definite modern English lines. Shades meant for halls and such-like places offer a really splendid opportunity to the decorator who designs, as so many modern artists do, mainly in masses and aims rather at the effect of silhouettes. There is no reason why simple shades of this kind should not be produced at a very moderate price, or why they should not be extraordinarily telling and effective.

GENERAL NOTES.

Forestry Regiment. — A "forestry regiment," made up of foresters, practical woodsmen, loggers, portable sawmill operators, and others experienced in lumbering operations, for service in France, will, it is announced by the *Paper-Maker,* be raised immediately in the United States. The Forest Service, at the request of the War Department, will prepare plans for the organisation and equipment of the force and will aid in securing suitable men. The regiment will form a unit of the Engineer Corps now being recruited to be sent abroad as soon as it can be organised and equipped. The organisation of this regiment is the result of a suggestion made by the British Commission. Similar forces have been raised in Canada and are rendering valuable services. The object of the American forestry regiment, it is said, will be to convert available timber into material suitable for bridges, railroads, trenches, and other construction work with the least possible waste. At the same time the cutting will be done under the supervision of technical experts in co-operation with the French foresters.

Copper-mining in India.—The Indian Munitions Board are endeavouring, says the *Pioneer Mail,* to revive the copper-mining industry in India, and that there is plenty of room for this development is shown by the fact that the imports of copper into India now approach to something like £2,000,000 sterling—to say nothing of brass, which is also imported to a considerable extent. Experts are being sent out from England to develop the industry on scientific lines under the direction of Sir Thomas Holland, the President of the Munitions Board. Copper was formerly smelted in considerable quantities in Southern India, in Rajputana, and at various places along the outer Himalayas. In Chota Nagpur several attempts have been made to work the deposits, which are reputed to be rich in the metal; but in such attempts the ore has been smelted for the metal alone, and no attempts have been made to utilise the sulphur as a by-product. It is to develop the industry on these lines, utilising the ore to the fullest extent possible, that the experts have been sent out from England.

Canned Salmon of the Pacific Coast, 1916. —The gross value of the canned salmon pack of 1916, according to the *Pacific Fisherman Year Book,* amounted to £8,708,527. More than half of this was contributed by Alaska. Siberia is rapidly coming to the front with a pack of 425,800 cases, valued at £423,115. As has been the case for a number of years, the pack of Alaska exceeded that of any other section, being more than twice as large as all the others together. British Columbia is second, followed by Puget Sound, Columbia River, Siberia, Oregon Coast, Washington Coast, Japan, and California, in the order named. The total pack on the American side was 7,355,612 cases, and on the Asiatic side 473,600 cases—a gross total for the Pacific of 7,829,212 cases. It should be noted that whereas in former years practically all the catch was canned, more recently large quantities of fish have been mild-cured, pickled, smoked, frozen, or sold fresh. If the fish so disposed of had been canned in 1916, the pack would have exceeded that of any other year in the history of the industry.

The Great Lake Water-power Scheme, Tasmania.—The *Engineer* contains an account of the Tasmanian Government's Great Lake hydro-electric power undertaking, which was opened last year. It is based chiefly on a joint utilisation of two rivers, the Ouse and the Shannon, the latter of which has its source in the Great Lake, and the former in the Ninety-nine Lagoons. The Great Lake is 3,250 feet above the sea, and the lagoons about 200 feet higher. In spite of the fact that their sources are so close, and their junction only some twenty miles downstream, there is a great dissimilarity in their gradients. At one point, about five miles south of the Great Lake, the Ouse is actually 1,300 feet below the Shannon. A dam has been built across the south end of the lake, giving an additional depth of 11 feet, and increasing the storage area from forty-two to fifty square miles. The catchment basin lies in the centre of the island, and is some 227 square miles in extent, and the annual precipitation of rain and snow is upwards of 60 inches. The water of the Shannon is turned into a canal, which serves as a storage reservoir of 380 acres. The power-station is on the banks of the Ouse, which receives the exhaust water. The difference in level from reservoir to power-station gives a net head of 1,015 feet, sufficient to develop an output of 4,900 brake-horse-power in each of the two turbines now installed. Although at present it only serves the town of Hobart, the central position of the station makes it convenient for the transmission of power to any point in the island.

Japan to Build Ships for Great Britain.—*Page's Engineering Weekly* announces that a big order has just been received by the Kawaisaki Dockyard Company of Kobe from Great Britain. The total value of ships ordered amounts to more than 50,000,000 yen. The present order from Great Britain consists of 14 freighters, the tonnage of which ranges between 9,000 tons and 12,000 tons. The British buyer will pay 40,000,000 yen in cash and 10,000,000 yen in either British or Japanese securities, while the ships will be delivered one after another on their completion.

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PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

THE SHORTAGE OF THE SUPPLY OF NON-PHOSPHORIC IRON ORE.*

By William George Fearnsides, M.A., F.G.S., M.Inst.M.E.,

Sorby Professor of Geology, University of Sheffield.

Lecture I.—Delivered April 30th, 1917.

Introduction.

When some months ago I accepted your Secretary's invitation to come as deputy for my busy friend Dr. Ripper—newly appointed Vice-Chancellor of the University of Sheffield—to address you here to-day, the grim warning which Mr. Lloyd George delivered to the nation on February 23rd, concerning the effects to be expected from the enemy's unrestricted submarine campaign upon the supplies of iron ore which come to us from overseas, had not been given; and the title announced for this course of two lectures was chosen to give me the opportunity to present to you an amplification of some conclusions to which I was drawn when, last year, I made a conspectus of the mineral production which was required to feed the iron and steel industry of this country in the years before the war.

From the evidence assembled in a paper which I read before the Society of Engineers last December,† I had concluded that, already in the pre-war years, supplies of the hæmatite ores required for the making of the class of steel which is most in favour among British engineers were getting short; and in times to come it will certainly be necessary *either* to fetch by ship hæmatite ore from sources ever more and more distant from this country, *or*, by applying improved metallurgical processes to the refining of lower-grade material, to utilise the supplies of ores which occur in close proximity to our coalfields, and from these to produce reliable substitutes for the "Bessemer grade" acid steels which at present are chiefly in demand. As it is with the intention of drawing a comparison between these two alternatives that I have selected the subject for these two lectures, I may say at once that, in my opinion, it is the latter which will eventually work out to the national advantage, and that I am in complete agreement with those in authority who have pointed out that if additional labour can be provided for digging the supplies of somewhat lean ores which are in sight in home mines and quarries, and for handling the greater bulk of material and dealing with it as it passes through our blast furnaces and steel refineries, the country is quite in a position "to augment by millions of tons a year the quantity of ore which could be produced in this country," and thereby greatly to reduce the burden upon its shipping.

Whether, in peace-time, the produce from the smelting of these low-grade ores could continue to bear the cost of handling as well as that of the additional refining processes which would be necessary in order to make, from the foundry pig-iron which normally they yield, a reliable substitute for "hæmatite" steel, is another matter, and one which only practical works experience can decide; but as a commercial proposition the success of the German pre-war policy of using for all possible purposes pig-iron obtained by smelting the cheap and accessible ores of Lorraine—refining the metal only just sufficiently to meet the purpose in hand—can hardly be gainsaid. In time of war, the necessity for economy in the use of shipping tonnage, for carrying from distant ports a

* The course consisted of two lectures, delivered on April 30th and May 7th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into three parts.

† "The Mineral Requirements of the British Iron and Steel Industries." *Transactions of the Society of Engineers*, January, 1917.

TABLE SHOWING BRITISH OUTPUT OF IRON ORE, 1915.

Compiled from Statistics published by the Home Office, Mines, and Quarries General Report, Part III., issued 1917.

By Counties.

County.	Quantity of Iron Ore.	Quantity of Pig-iron obtainable.	Difference.*	
	Tons.	Tons.	1914.	1913.
York	4,821,465	1,446,413	–	–
Northampton	2,517,150	813,143	+	–
Lincoln	3,149,079	809,666	+	+
Cumberland	1,323,408	697,965	+	–
Stafford	703,231	211,071	–	–
Leicester	685,137	188,705	–	–
Lancaster	333,086	173,522	–	–
Ayr	136,996	41,099	–	–
Oxford and Rutland	140,520	38,377	–	–
Glamorgan	67,981	33,542	+	+
Lanark	68,101	20,430	–	–
Renfrew and Inverness	56,206	16,862	–	–
Antrim	39,326	15,273	–	–
Linlithgow	48,014	14,404	+	+
Stirling	41,352	12,406	–	–
Carnarvon	23,318	9,327	+	+
Wiltshire	19,486	5,846	+	+
Edinburgh	16,373	4,912	–	–
Durham	10,729	3,862	+	+
Monmouth	7,778	2,334	–	–
Gloucester	6,182	2,143	+	–
Fife	7,031	2,109	+	+
Warwick	4,338	1,314	–	–
Salop	3,560	1,068	+	+
Kent	2,458	738	+	+
Worcester	1,468	440	–	–
Dumbarton	1,168	350	–	–
Devon	40	21	–	+
Derby	31	9	–	–
Total home output	14,235,012	4,567,351	–	–
Foreign ores imported	6,197,155	4,151,051	+	–
"Purple ore"	677,600			
Total	21,109,767	8,724,402		
Less quantity exported	1,684	842		
Available for furnaces	21,108,083	8,723,560	–	–

In 1914 there were other mines at work in Worcester, Somerset, Londonderry, Brecon and Derby. In 1913 mines were also worked in Denbigh and Merioneth.

* The signs + and – indicate respectively an increase or decrease of output in 1915 as compared with the two previous years.

material so bulky as is iron ore, is paramount, and it has become a matter of national urgency that all such home supplies of ore as are, or can immediately be made, available for our blast furnaces should be smelted, and so refined that the metal produced is suitable for purposes of war, whatever may be the cost.

AVAILABLE HOME SUPPLIES OF IRON ORE.

Output of Home Ironfields.

During this, the first of the two discourses which I am to devote to the subject of iron ore, I propose to deal more particularly with the known supplies of iron ore which are available in this country, and shall take as my key the quantitative data set out in the Home Office output returns in the Chief Inspector of Mines' Report for the latest published years. In the table we have, by counties, the tonnage of iron ore worked in the British Isles during the year 1915. We shall consider the items in this table in the order of the weights of pig-iron which the ores wrought in the various counties might yield when smelted.

York.—*Cleveland.*—First among the counties as a producer of iron ore stands the shire of the broad acres, which, by reason of the productivity of the Cleveland district, has maintained the premier position in this respect for more than fifty years. The working of the Cleveland Main Seam, which forms the topmost bed of the *Spinatus* zone of the Middle Lias, only began about 1850, but by 1856 the tonnage wrought exceeded a million tons a year, and in 1876 the year's output had grown to more than six million tons. The maximum productivity of the Cleveland district was attained in the early eighties, with 6,756,055 tons in 1883, since which date until 1915 the yearly output has never fallen below five million tons, so that the total tonnage won has passed 300 million tons. The ore bed is at its thickest (about 17 ft.) in the district where it was first opened up at its outcrop near Eston Nab. Down dip and along the outcrop the thickness varies somewhat irregularly, but on the average it becomes thinner in an easterly and southerly direction. Over a total area computed at about 350 square miles there is said to be an average of more than 6 ft. of workable ore. South of a line joining Robin Hood's Bay to Thirsk, inconvenient partings of hard shale come in in the middle of the ore, and subdivide the seam so that in all the district south of Kildale the seam is so split up that the working of it is unprofitable. Some five-and-twenty mines, employing nearly ten thousand men, are now at work in the northern district, and it is very probable that in these mines the winning of the ore reserves already proved and opened up could find employment for almost twice the number of men who are now engaged, and that with such additional skilled labour the output of the mines could be proportionately increased.

Underlying the Main Seam, and separated from it by a hard shale which varies from little more than a parting to a rock mass several feet thick, occurs the *Pecten* Seam, which is of greatest economic interest in Southern Cleveland about Grosmont and Rosedale, where the Main Seam is so split up by partings as to be unworkable. This *Pecten* Seam varies in thickness from about 2 ft. 6 in. to 4 ft. 6 in., and in quality is not inferior to the Main Seam. About a score of feet below the *Pecten* Bed, a group of beds known as the *Avicula* Seam, also of good quality but of irregular thickness, underlies almost the whole of the Cleveland district, and has been exploited at a few localities.

In addition to the ironstones of the Middle Lias Series, the basal bed of the overlying Bajocian Series, known as the Cleveland Top Seam or Dogger Ironstone, has on occasion been worked along the valley of the Esk. In former days this seam proved specially valuable in the Rosedale mines, where it was known as "the seam of the district." Generally, however, its ore is too silicious to be much in request among Cleveland ironmasters. The circumstance that the quality improves and the thickness increases southwards, just where the other seams are dying out, suggests that by boring further to the south and east valuable reserves of workable ore may be discovered beneath the cover of newer rocks within the district drained by the River Derwent.

As mined, Cleveland ore is generally a blue or green-grey oolitic rock, in which the carbonate of iron occurs as oolitic grains. In the analyses silica is shown to form at least 8 per cent., and on occasion up to about 20 per cent. of the rock, but the bases, more especially lime and alumina, are also present in such proportion that the ore is almost self-fluxing. The sulphur percentage is not high, averaging about 0·1; but phosphorus is moderately abundant, and if the pig-irons which Cleveland ore yields when smelted with Durham coke are to be made into steel, the "basic" process is needed for its refining. It is worthy of note that the famous Thomas and

Gilchrist basic process, which is the basis of all the modern German practice of steel-making from pig-irons smelted from Lorraine ores, was invented and perfected at Middlesborough between 1877 and 1881 for the purpose of converting Cleveland pig-iron into steel. In Great Britain the process has been taken up much more slowly than on the Continent, partly because our engineers are conservative in their practices and have been very suspicious of the reliability of any except acid steel, and partly because in this prejudice they were encouraged by ironmasters who had vested interests both in the plant required for carrying on the acid process and in the mines from which hæmatite ore is wrought. In recent years, however, it has been generally recognised that best-grade hæmatite ore is becoming scarcer, and a fresh impulse has thus been given to the basic steel industry of the Cleveland district; and at the present time pig-iron made from phosphoric Cleveland ores almost without admixture is being converted directly into steel on a very considerable scale. The average iron content of Cleveland ores is about 30 per cent., and, seeing that the average value of the ore at mine was in 1915 only 5*s.* 4*d.* per ton, it seems probable that Cleveland is one of the districts to which the nation may look for an increase of production of cheap iron ore in this time of need. It may be noted that between 1912 and 1913 the output of ore from Cleveland was increased by 852,360 tons. In 1910 Professor Louis estimated the available ore reserves of Cleveland at 3,000,000,000 tons.

Additional to the 4,746,293 tons of ore produced by mines in Cleveland, a further 51,321 was obtained from open quarries working the outcrop of the Cleveland Main Seam, and there is also the item 23,851 tons of ore noted as wrought from mines which are also working coal in the West Yorkshire coalfield.

West Riding.—In the pre-steel days, when puddled iron was the standard material for good-class engineering construction, clay-ironstone wrought among the Coal Measures in the districts between Leeds and Bradford and between Barnsley and Sheffield produced a considerable output (in 1868, 785,028 tons) of iron ore, which formed the staple raw material of the very important wrought-iron industry. With the coming of the Bessemer and open-hearth methods of steel-making, the demand for this class of ore began to fail, and though the ore exists in plenty and is not inaccessible when the coal is being won, the labour costs for getting it are so high that, unless improved metallurgical practice can develop a method for making steel from it in a single operation, the numerous thin beds of clay-ironstone which are interstratified with shale in almost every part of the Yorkshire Coal Measures are likely to remain unworked.

Northampton.—Being separated by a considerable distance from the coalfields, the development of the iron industry of Northampton suffers under the handicap of considerable freight charges; but the low price at which the thick ironstone bed which forms the basal bed of the Inferior Oolite or Bajocian Series within this county can be worked has, since the eighties, enabled it to vie with Lincoln for second place among the counties as a producer of iron ore; and so long as weathered ore from the outcrop is available and can be put in truck at prices round about the 2*s.* 9*d.* per ton quoted for the ore mined in 1915, it should continue to hold its place.

The Bajocian ore bed extends in some form or other from Steeple Aston in Oxfordshire, along the whole length of Northamptonshire, northward almost to Lincoln; but at present the active workings are situate to the north of the London and North-Western Railway main line from Rugby to London, and south of the River Welland. Like the geologically contemporaneous Cleveland Top Bed or Dogger Ironstone of Eskdale in Yorkshire, mentioned above, the Northamptonshire ironstone is distinctly a silicious ore, and where, in the deeper levels, the oolitic grains which are characteristic of the unweathered ore remain, the ore is sometimes so silicious as to be unsuitable for smelting. Some forty-five quarries and seven mines, employing 2,500 men, were active in Northamptonshire in 1914. The proportion of quarries to mines is characteristic of the relatively high esteem in which the weathered material from near the outcrop is held by the ironmasters who are purchasers of the ore.

Fortunately the ironstone district of Northampton is a region of considerable topographical relief, and as the dip of the measures is slight, the area over which outcrop material is available for working by open-cut is very considerable. Louis has estimated the potential ore reserves of the Northampton ironstone district at 1,000,000,000 tons, but there will have to be some improvement of metallurgical processes before the unweathered carbonate ore, rich in silica, as found in depth, can enter into

economic competition with the more concentrated and less silicious weathered ores. The average iron percentage of the ore won in 1915 was 32·4. The working of iron ore in Northampton only began in 1851, and the output attained 1,000,000 tons per year in 1871. The rise to over two million tons only arrived with the present century, and, since the national need has arisen, and especially now that pig-iron made from Northampton ore can be adapted for steel-making, there is no reason why the yield of iron ore from this district should not be still further increased.

Lincoln, like Northampton, is a county with no coalfield within its borders, but with the development of the railways needed to carry surplus production of coal from the Yorkshire, Derbyshire and Nottinghamshire coalfield to seaboard for shipment, facilities for bringing fuel to the ironstone or taking ironstone to meet the fuel have in recent years improved, and the iron-ore output of the county has found a ready market. Since the war the tonnage of ore wrought in Lincoln has increased considerably, and the county has advanced to second place.

Rocks older than the Mesozoic have no outcrop within the county of Lincoln, and the various ironstones there worked are all of Jurassic age. Most productive among them are certain beds of shelly ironstone interbedded with the limestones of the *Semi-costatus* zone about the middle of the Lower Lias, in the Frodingham district of North Lincolnshire just south of the Humber. The thickness of the beds worked is in places (*e.g.* at Appleby) as much as 25 ft., and though the iron content of the ore is low (only 25·6 per cent. of metallic iron on the average), the low dip of the measures and the character of the topography of the district allow it to be worked by open-cut for over a mile in from the outcrop, and a large tonnage of ore can therefore be gotten very cheaply (in 1915 the value at quarry was less than 3*s.* 6*d.* per ton). The circumstance that the calcareous impurities are such that to some extent this ore can be used as a flux in smelting more silicious ores makes it a valuable national asset. By boring, the Frodingham or Scunthorpe ironstone beds have been proved to extend eastward down dip for several miles, and, unlike the Bajocian ores of Northampton, they do not seem to have deteriorated in quality where proved under considerable cover. Along their outcrop, the *Semi-costatus* beds have been exploited from Whitton on the Humber as far as Scotton, some fourteen miles to the south. The ore reserve was estimated by Louis in 1907 at 100,000,000 tons. Some sixteen quarries working in North Lincolnshire in 1914 employed over 1,000 men.

Quite at the other end of the county of Lincoln, at Leadenham and Honington to the north, and at Woolsthorpe to the south, of Grantham, platey calcareous ironstones, in appearance not unlike those at Frodingham, are quarried and sent to Derbyshire for smelting. These beds, however, belong to the Middle Lias, and, being full of *Rhynchonella tetrahedra*, may be counted the Lincolnshire equivalent of the Cleveland Main Seam. The ore bed varies from 3 ft. to 10 ft. in thickness, and is mostly worked by open-casting.

At Greetwell, in the Witham gap about two miles east of the city of Lincoln, a local development of the basal Bajocian—the equivalent of the Northamptonshire ironstone beneath the Lincolnshire limestone—has been worked both by mining and by open-casting for many years, and is still productive, about 100 men being employed in 1914.

The mines which formerly worked a 6 ft. bed of somewhat silicious ironstone associated with Neocomian strata about Claxby and Tealby, at the foot of the Lincolnshire Wolds, have been closed down for many years.

The working of ironstone in Lincolnshire was first begun about 1858. By 1880 the annual production had grown to 1,000,000 tons, and in recent years the output has increased to over 3,000,000 tons per year.

Cumberland.—So far as the money value of the ore won in 1915 is concerned, Cumberland stands first among the counties, and from its mines comes fine hæmatite which ranks among the richest and purest iron ore that the world yet knows. Unlike the bedded ores of Yorkshire, Lincoln and Northampton, already dealt with, Cumberland hæmatites occur as veinstones or as irregular masses, which are regarded as metasomatic replacements of limestone and have a conformation which depends upon the arrangements of the faults, joints, open bedding planes and other fissures which traverse the massive limestones of the Lower Carboniferous system or the older or newer rocks which these adjoin. By reason of the manner of their occurrence, until by mining the extent of any particular ore mass has been proved, it is never possible to predict either the dimensions or the shape of the ore bodies, and mining for hæmatite in Cumberland, as in other parts of the world, partakes therefore of the specu-

lative character which is a feature of the working of most metalliferous mines. Unless, therefore, exploratory development can proceed *pari passu* with the bringing of ore to bank, the output of individual mines is always liable suddenly to slump. Nevertheless, as is the case with most other types of veinstones and impregnations, the hæmatite of Cumberland occurs under geological conditions which can be fairly closely defined, and where particular horizons (especially near the top and adjoining the unconformity at the base of the massive limestone series) are cut either by N.-S. or by E.-W. faults, the hæmatite ore bodies are especially abundant. A few veins carrying hæmatite in quantity sufficient to have tempted exploration by the iron miner have been proved where they traverse the Ordovician and Silurian rocks beneath the Carboniferous unconformity, and especially across the junction where the Eskdale and Ennerdale granite rocks cut these ancient Palæozoic sediments, a few of the veins are rich enough to have been worked with economic success. Most of the best hæmatite of Cumberland is to a certain extent porous or cellular; where the ore is hard and compact, the cells, pores or loughs are found filled with crystalline silica, and it is noteworthy that alongside of many of the hæmatite veins the country rock, where originally it was calcareous, has been completely silicified. The average ores obtained from Cumberland in 1915 were estimated to contain 52·74 per cent. of metallic iron; silica up to 16 per cent. and a little mechanically entangled limestone being the only important impurities.

Most of the Cumberland mines are situate in the Whitehaven district, along a more or less south-west and north-east belt, from Beckermet through Egremont, Cleator Moor, and Frizington to Lamplugh; but Hodbarrow, the largest and most productive of them all (employing over 1,000 men), works a great "dish-like" concentration of ore among limestone rocks beneath the Pleistocene or recent deposits of the Duddon Estuary south of Millom. Forty-two mines employing nearly five thousand men were at work in Cumberland in 1915.

Worked since the twelfth century, the annual output of the mines of Cumberland has since 1870 generally exceeded a million tons per year. Their maximum output for any one year was 1,725,478 tons in 1882. As a minefield the area shows no signs of exhaustion, and if exploration and development can be undertaken in advance of actual winning operations, there is no reason why production should not in the future be considerably increased. For the production of high-grade "acid" steel, such as is required for the making of tools, guns, and moving parts of high-class machinery, there is no known supply of iron of better quality than that made from the hæmatites of Cumberland and Lancashire, as smelted with coke brought over the Pennines from Durham and Northumberland; and if, by augmenting the labour supply, the productivity of these "West Coast" mines could be increased, by so much would the demand for best Bessemer-grade hæmatite from Spain and Mediterranean countries be diminished.

Stafford.—As a producer of iron ore from the Coal Measure ores, the Potteries district of North Staffordshire is less decadent than any other of the British coalfield districts, and from it, in 1915, from the twenty-seven collieries concerned, an output of 671,503 tons of "black-band" and "clay-ironstone" was produced. The most important of the ironstone beds worked are four black-band seams known as the Half Yard or Black-band (1 ft. 6 in. to 3 ft. thick), the Redshagg (9 in. to 7 ft.), the Red Mine (1 ft. to 14 ft.), and the Bassey Mine (1 ft. 6 in. to 5 ft.), which occur associated with thin coals in measures which lie below the Etruria Marls, and belong to the upper part of the productive Coal Measures.

In comparison with the output from the Potteries district, the 30,817 tons of ironstone obtained from forty-six mines and 911 tons from quarries, in the Black Country of South Staffordshire, is of little importance. Malleable iron for the special industries of the Black Country is the purpose to which Staffordshire black-band ores are most generally applied; but, being somewhat "refractory," they are generally smelted along with some clay-band ironstone and with silicious ore from Northampton.

Half a century ago the productivity of Staffordshire mines was much more considerable, and we may note that only in one single year between 1860 and 1890 did the Staffordshire output fall below a million tons. The year of maximum productivity was 1871, when 2,218,745 tons of ore was won. No doubt, if economic conditions would allow, a similar output could again be reached; but the cost at mine (9*s*. 6*d*. per ton in North Stafford and 10*s*. 11*d*. in South Stafford), for ore which averages little more than 35 per cent. of metallic iron and carries a considerable percentage of sulphur along with some phosphorus, renders it unlikely that any but the thicker beds of black-band will be

worked for other than the special purposes of malleable iron-making as distinct from the steel industry.

Leicester.—The ironstone of Leicestershire is the immediate continuation of the Marlstone belt of the Middle Lias, which has already been remarked upon as occurring in the Grantham district of south Lincolnshire, and extends south-westwards along the ridge overlooking the Vale of Belvoir as far as Wartnaby, quite near Melton Mowbray. The chemical characteristics of the ironstone from this district are said to be quite like those of the Cleveland Main Seam, but, being as yet only worked in shallow quarries along the outcrop, it is sent to furnace in a considerably more oxidised and weathered state. The cost of working in 1915 by open quarries was only a fraction over 2*s.* per ton, and though the metallic iron yielded is only 27·45 per cent., it would appear to be to the nation's advantage that the productivity of the Leicester ironfield should be further increased, so that the phosphoric pig-iron which the ore yields when smelted can be made available for conversion into basic steel. Ironstone quarrying in Leicestershire only began in 1881, but by 1890 the output had advanced to nearly one million tons per year.

Lancaster.—Most of what has been said about the mode of occurrence and the quality of the ores of Cumberland applies equally to the hæmatite deposits of the Carboniferous Limestone district of Furness in Lancashire, which adjoins the Cumbrian massive on the south. Begun by the ancient Britons, the hæmatite mining industry of Furness attained considerable importance at an early date, and until the early eighties of last century the annual production of hæmatite from Lancashire was almost equal to that of Cumberland. Since 1882, when the output was 1,408,693 tons, the productivity of the Lancashire mines has waned considerably, and it would almost seem that, failing new discoveries in the exploration of ore bodies in the limestone area which lies beneath the waters of the Irish Sea, even the present rate of output from Furness can hardly be long maintained. Sixteen hæmatite mines, mostly in the neighbourhood of Dalton-in-Furness, were active in Lancashire in 1915, and gave employment to over 1,200 men. The quality of the iron ore won is not distinguishable from that mined in Cumberland.

Scotland.—Except for the produce from quarries, and from mines recently opened in the Marlstone beds of the Middle Lias on Raasay, an island of the Inner Hebrides situate between the Island of Skye and the mainland, all the ironstone gotten in Scotland is won from mines worked among the coal-bearing measures of either the Lower or Upper Carboniferous, and is of the varieties known as black-band and clay-ironstone, and is similar in character to the ironstones worked in Staffordshire. Started about 1830 for the purpose of smelting these Coal Measure ores, the blast-furnace industry of Scotland during the middle fifties was dealing with about 2½ million tons of locally-won ironstone per year. Lapsing a little in the sixties, the industry revived again in the seventies, and the Scottish ore output reached its maximum in the year 1880, when 2,659,317 tons of ore were won. With the introduction of steel instead of iron for shipbuilding, the particular class of iron for which Scottish Coal Measure ores are suited has become too expensive (12*s.* 1*d.* was the average value at pithead of the 375,241 tons of 35 per cent. Fe. ore won in Scotland in 1915), and though abundant reserves of similar ores are available if required, it would seem unlikely that the present generation can, except for special purposes, afford to make use of them on a more extensive scale.

Among the Scottish counties we note that Ayr, with only four mines now working ironstone, produced the greatest output (136,996 tons) in 1915; followed by Lanark with six mines; Renfrew with three; Linlithgow, ten; and Stirling, ten. In recent years Linlithgow and Fife are the only Scottish counties which have increased their iron-ore production.

Oxford and Rutland.—The ore wrought in *Oxfordshire* is obtained from shallow quarries along the outcrop of the Marlstone beds of the Middle Lias, which, between the valleys of the Cherwell and the Evenlode west of Banbury, forms an extensive dip-slope and culminates in the escarpment of Sunrising and Edge Hill, just over the county boundary in Warwickshire. The quality of the ironstone of the Banbury district is similar to that wrought in Leicestershire, and it is said that only the unfavourable disposition of the railways which carry the ironstone to meet the fuel has prevented the development of the Oxfordshire ore quarries on a like scale to those in the district north of Melton Mowbray. According to newspaper information, railway development designed to open up these ironstone deposits from the Edge Hill side is actually in progress at the present time.

The ores of *Rutland* are quarried from the northward continuation of the outcrop of the basal Bajocian ore bed of Northamptonshire, which is being worked between Cottesmore and Market Overton. The ores from this district are somewhat more silicious than the average of the equivalent ores of Northamptonshire.

Glamorgan.—Except for the small item of 7,985 tons of clay-ironstone obtained from coal mines, the iron ore won in South Wales comes from a single group of mines working a mass of metasomatic brown hæmatite or limonite at the top of the Carboniferous Limestone at Llanharry, about halfway between Cardiff and Bridgend. The hanging wall of this "dish-like" mass in some parts of the mine is Coal Measures, and in others the Dolomitic Conglomerate of the Trias. There has been no important discovery of new limonite ore bodies in Glamorgan for many years; but the mines about Llantrissant and Llanharry, which attained their maximum activity in the late sixties and early seventies (the output for 1874 was 120,894 tons, and thereafter gradually waned until in the nineties the annual production was less than 10,000 tons), have in recent years been revived with considerable success. The average iron content of the ores recently won at Llanharry exceeds 50 per cent.

Ironstone working in the South Wales and Monmouth coalfield attained its maximum activity in the early seventies, when in 1872 1,174,828 tons of clay-ironstone was produced.

Antrim.—The only iron ores worked on a considerable scale in Ireland are limonites, obtained, along with bauxite, from what was once an old surface soil formed during the interval between the eruption of the Upper and the Lower Basalts of the great volcanic plateau of Antrim and Londonderry. These iron ores carry a high percentage of alumina, and being low both in phosphorus and sulphur, are sought after for use as a flux for reducing the more silicious of the hæmatite ores of Cumberland and Lancashire, or with other hæmatite ores imported from abroad. The ore bed extends over a wide area, and though the cost of mining (7*s.* 10*d.* per ton in 1915) is rather high, only the difficulties of transporting the ore to furnace prevent the deposit being worked as formerly on a much more extensive scale. The mines were first opened in 1861, and the maximum output (239,315 tons) was attained in 1880.

Carnarvon.—The iron ores worked in Carnarvonshire, as also in Merioneth, are lenticular masses of ferruginous pisolite, which occur along crush-belts among certain altered Cambrian or Ordovician slate rocks in a region which was once the site of considerable volcanic activity. The individual ore bodies are narrow and of no great lateral extent, and as in depth the sulphur content of the ore increases considerably, the North Wales district can hardly be looked upon as a useful reserve of iron ore, although its output in 1915 shows an increase on the production of the two previous years.

Wiltshire.—Notwithstanding its remoteness from other centres of the iron industry, the Westbury iron industry continues to exist, and smelts ore from an 8-ft.-thick ironstone bed which underlies the Kimmeridge clay and is a local development of the highest beds of the Corallian series. The Westbury ore is somewhat silicious, but, carrying on the average about 30 per cent. of iron, is richer than the average of British Jurassic iron ores. Similar ore bodies are developed sporadically along the outcrop of the Corallian series southwards as far as Abbotsbury on the Dorset coast.

The Lower Greensand ironstone until recently worked at Seend, about halfway between Bradford-on-Avon and Devizes, is a sort of hard-pan or carstone concretionary ore which has probably been formed by the concentration of products formed from the oxidation of glauconite. Except where the sandy matrix in which the hard-pan lies is so loose that it can be removed by screening, the Seend ore is too silicious for general blast-furnace purposes.

Durham.—The only iron ore now wrought in Durham is obtained from the "barren" parts of the mineral veins which in other parts carry lead and zinc ores, fluor-spar, barytes, etc. These veins follow joints or faults, which traverse the Yoredale shale and limestone series of Northern England, and are especially abundant in upper Weardale on the borders of Durham and Cumberland. In depth the iron ore mostly occurs as a spathic siderite, but nearer the surface a good deal of it is found as cellular limonite, which has often taken on curious mamellated forms. The width of individual veins is variable, and has been known to alter from a few inches up to as much as 14 ft. or even 20 ft. within a few score yards. The quality of the ore is good, and among British ores it is notable in that with 36 per cent. of

iron there is sometimes as much as 5–10 per cent. of manganese. In general it has not paid to develop the Weardale mines for the special purpose of working either the limonite or the spathic ironstone, and by the Durham miners the iron ore is regarded only as a by-product to be marketed when the lead ore is being opened out. The period of maximum production of iron ore in this district was in the seventies and early eighties when the price of lead was high (100,332 tons in 1870).

For clay-band ironstone production the great coalfield of Northumberland and Durham has never been a rival of either the Scottish or the South Pennine coalfields. Its maximum output (196,848 tons) was attained in 1871, and since 1880 it has not produced at all.

Gloucester.—The number of mines noted as producing iron ore in the Forest of Dean district of Gloucestershire is still considerable (sixteen), but in recent years the output recorded from them is very small. As an iron-producing district, history tells of its almost continuous activity from Norman times onwards, and finds of coins, etc., show that iron-smelting had been already begun there in the time of the Romans. The ore worked occurred in "churns" or caverns, which follow open joints or bedding planes, which are particularly abundant at horizons near the top of the Carboniferous Limestone series where the limestone beds are "crystalline." Probably in depth the unaltered ore occurs as veins of spathic carbonate, or as hæmatite mixed up with carbonates of lime or magnesia, but as worked it was a somewhat silicious brown or red limonite, not unlike that now being won at Llanharry, and its irregular cavernous nature may very probably be a correlative result of the alteration of iron to hydrated oxide and the removal of the soluble earthy carbonates in solution. The maximum production from mines in the Forest of Dean was attained in 1871, in which year 170,611 tons of limonite was won. Since that time the output has steadily declined, and until some big scheme is developed for proving the continuation of the ore bodies down dip into the water-logged area below the present coal workings, the Forest of Dean as an iron-mining area may be considered as exhausted.

Warwick, Salop, Worcester and Derby.—The small quantity of ore recorded as won from these counties is clay-ironstone obtained incidentally at the coal mines. In former days the output of Coal Measure ironstone was considerable, the small Coalbrookdale coalfield alone having produced 450,000 tons in 1864, while between 1855 and 1873 the output from Derbyshire never fell below 325,000 tons. Cost per ton of production, and consequent failure of the product to compete against the cheaper ores from Northamptonshire and the East Midlands generally, is the probable cause of the failure of the output in these Midland coalfield districts.

Devon, Cornwall and Somerset.—The probable cause for the failure of the iron ore production from South-west England in recent years probably lies in the circumstance that the ore bodies there are veinstones, and that the individual ore masses are of no very considerable size. Among the Middle Devonian rocks of the Brendon Hills veins of spathic ore rich in manganese were formerly worked for making spiegeleisen. Similar veins are known about Perran and near St. Austell in Cornwall, and also in the Exmoor district. "Potty" ore, associated with somewhat silicious red and brown hæmatite or limonite, has been worked on a considerable scale on the island headland south-west of Brixham, and "dish-like" pockets of red limonite have been worked out among the Middle Devonian Limestone outcrops on the south-east of Dartmoor. Narrow veins of true hæmatite have been proved where they traverse the boundary of the St. Austell and Bodmin Moor granite masses, and bedded ironstones, apparently interstratified with the Lower Carboniferous rocks of Smallacombe near Hay Tor, converted into magnetite where they have been baked by the great granite laccolite of Dartmoor, have been developed ready for working on a more extensive scale.

British Home Reserves.

Reviewing this information from the point of view of the economic geologist, we may emphasise the outstanding circumstance that in all the counties where the yearly tonnage of ironstone produced is large and on the increase, the rock-beds mainly worked belong to the Jurassic system, and almost invariably to the lower half of that system. The Marlstone bed at the top of the Middle Lias is outstanding as the ironstone formation *par excellence* of the British sedimentary series, and wherever the Middle Lias is so developed that it forms an escarpment —*e.g.* in Cleveland; along the eastern margin

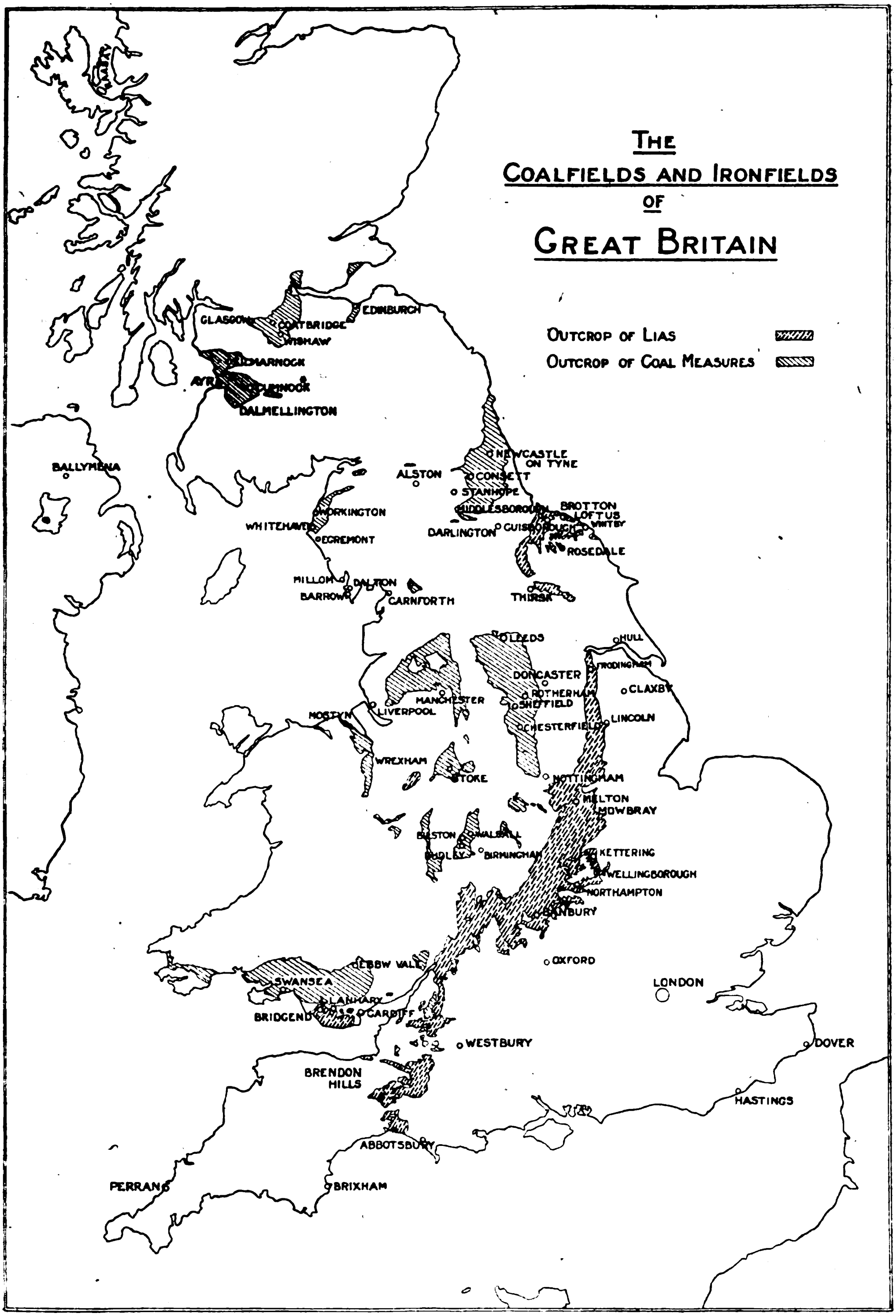
of the Vale of Belvoir; in Oxfordshire; and also off the west coast of Scotland in the Island of Raasay—there are interstratified ironstone beds of considerable thickness which are ferruginous enough to be worth working for iron ore. North of the Valley of the Thames in Oxfordshire, as far as Cleveland, wherever the Middle Lias escarpment dies down, the ferruginous material is less abundant at that horizon, but seems to have segregated to another part of the Jurassic succession; and such fine ironstone formations as those of the Lower Lias of the Frodingham district of Lincolnshire, and the basal Bajocian rocks (Allenian) of Northamptonshire, are developed in its stead. So abundant is the iron ore along the Jurassic belt that, except where short and easy lanes of railway communication between the ironfields and those coalfields which produce the right kind of fuel for blast-furnace use have allowed the ironfields to be developed quickly, even the surface outcrop of the measures has been no more than scratched. Only in the Cleveland district, where the iron mines are practically within sight of the collieries of the Durham coalfield, has underground mining had to be resorted to on any considerable scale. In the case of siliceous ores, such as those of Northamptonshire, this is probably a circumstance very fortunate for our generation, for at the surface, by age-long exposure to the action of the weather, the chalybite (ferrous carbonate) of the oolitic grains (in which form the iron mineral is always found where the ore has been proved in depth), has been converted into limonite (hydrated ferric oxide), and thereby made less liable to slag during the smelting process with such quartz sand grains as happen to be present. South-westwards from Oxford beyond the valley of the Evenlode, the conditions which control iron segregation among the Jurassic rocks seem to have been less favourable, and there is little evidence even of "old men's" workings in the Marlstone outcrop either in the Cotswolds or the country to the south. Near Westbury in Wiltshire, however, and again at Abbotsbury on the Dorset coast, a thick bed of ironstone having certain very desirable properties forms the topmost beds of the Corallian, and if communication between these districts and the coalfields could be made less difficult, as ironfields they would probably be developed on a very considerable scale. It is interesting to note that in sinking through the Jurassic rocks to the Coal Measures a thick bed of similar ironstone has been discovered in the shafts of the Snowdown and Tilmanstone Collieries near Dover in Kent.

According to the estimate made by Professor Louis, the reserves of English Jurassic ores counted as workable under the economic conditions which held in Britain in the years before the war probably amounted to 800 million tons, beyond which a further 4,200 million tons is mentioned as not workable under the existing economic conditions, but as lying in reserve.

It is a matter of national concern that practically all the ironstone obtained from the Jurassic ore belt (*i.e.* over 80 per cent. of the total British production) is phosphorus-bearing, and that the pig-iron which it yields when smelted, if used for steel-making, must be refined upon a basic hearth. Fortunately, in certain beds occurring in the Magnesian Limestone (Permian), the outcrop of which, from Nottingham in the south to Sunderland in the north, along a belt which runs parallel to that of the Jurassic rocks and lies between them and the coalfield, the country has a plentiful home supply of dolomite, which, when properly calcined and shrunk, affords an excellent material for the making of basic hearths. Given, therefore, the necessary labour and the railway facilities for carrying the ore won to meet the coal, it is evident that an iron and steel industry which takes as its essential raw material the ore got by quarrying and mining among the Jurassic rocks of Britain is one which is capable of almost indefinite expansion.

For tonnage ranking next after the ores from the Jurassic ironstone belt, and for the money value of their products hardly yet ousted from the premier position, come the ores associated with the Carboniferous Limestones and the Coal Measures of the Carboniferous system. Pre-eminent among these, and of particular importance for high-class steel production at the present time, are the non-phosphoric hæmatite ores which occur as veinstones and metasomatic replacements following fissures in association with the compact and crystalline limestones of the Lower Carboniferous in the neighbourhood of the Lake District hills. Unfortunately, the ore bodies from which this hæmatite is won are less orderly in their occurrence than are the bedded Jurassic ores, and are therefore correspondingly expensive to exploit.

Worked continuously from old time in Furness and Cumberland, the older mines have shown signs of working out, and though in recent years, by the application of the diamond drill to underground exploration, some progress has been made in Cumberland in the location of valuable bodies of hitherto untouched ore,


The
Coalfields and Ironfields
of
Great Britain
Outcrop of Lias
Outcrop of Coal Measures
Glasgow
Coatbridge
Wishaw
Edinburgh
Ayr
Dalmellington
Ballymena
Alston
Newcastle on Tyne
Consett
Stanhope
Workington
Whitehaven
Egremont
Darlington
Guisborough
Brotton
Loftus
Whitby
Rosedale
Millom
Dalton
Barrow
Carnforth
Thirsk
Leeds
Hull
Frodingham
Doncaster
Rotherham
Sheffield
Claxby
Manchester
Liverpool
Mostyn
Chesterfield
Lincoln
Wrexham
Stoke
Nottingham
Melton
Mowbray
Walsall
Dudley
Birmingham
Kettering
Wellingborough
Northampton
Banbury
Oxford
Ebbw Vale
Swansea
Llantrisant
Bridgend
Cardiff
London
Westbury
Dover
Brendon
Hills
Hastings
Abbotsbury
Perran
Brixham

despite increasing demand and rising prices, in the not far distant future a time will come when the known deposits must give out. In Gloucester, where conditions are not dissimilar, the time of actual exhaustion has already arrived; in the Furness district of Lancashire production has diminished to less than one-third of what it was in the eighties; and even in prosperous Cumberland the zenith of hæmatite production seems to have been passed. The shortage of home supplies of hæmatite ores is in fact already with us, and there is little expectation that the 11 per cent. of our total home iron-ore production, which at present the hæmatite ore represents, can be considerably increased.

After the hæmatite won from veins in the Carboniferous Limestone rank the clay-band and black-band ironstones, which are still wrought on a considerable scale among the Coal Measures (especially in North Staffordshire—for the special purposes of the smiths of the Black Country—and in the coalfields of Scotland), and are still responsible for about 5 per cent. of the country's iron-ore production. At its maximum in 1856, the gross British production of black-band and clay-band ore from the Coal Measures amounted to 7,809,564 tons. In all years before 1865 ironstone production from the Coal Measures exceeded 50 per cent. of all ore raised in the country, and even as late as the early eighties was considerably in excess of five million tons per year. In recent years, steel made from imported hæmatite, from the cheaply worked low-grade Jurassic ores at home, or from a mixture of these materials, has replaced wrought-iron for general purposes, and a class of ironstone which has to be mined as bands only a few inches thick or as concretionary nodules scattered through a considerable thickness of clay, has little chance of competing successfully against material which can be loaded with a steam shovel; and it is very doubtful whether, except in some few districts where the individual beds are specially thick or have a composition which makes them specially suitable for particular purposes, the industry of iron-mining among the Coal Measures is likely to revive again. Economic conditions, and not exhaustion of material, are responsible for the diminution of iron-ore production from the Coal Measures, and though we may accept the 33,500 million tons of clay-band and black-band ore which Professor Louis has computed as lying in potential reserve in the various British coalfields, there is no reason to suggest that at the present time it represents to our ironmasters a national asset of any very considerable value.

(*To be continued.*)

POTASH FROM CALIFORNIA SEA KELP.

The potash problem in America, according to the *Popular Science Monthly* (New York), has been successfully solved. The supply of raw material for its manufacture costs little, and is practically inexhaustible. Near San Diego, California, undersea reapers are harvesting kelp, from which potash equal to about three times the annual importation from Germany previous to the war is made by one concern; a second plant of about equal capacity has been established in the same vicinity, and a smaller plant installed by the Government is in operation. Just now the manufacture of munitions requires all that can be produced, but America can obtain all that is required for herself and her Allies.

The reaper cuts the weed 4 ft. below the water surface when empty and 6 ft. when loaded, the depth having been made a Government regulation for conserving the supply. Each of the three boats of the "Hercules" fleet takes about 500 tons every working day, which means practically every day in California. The cut kelp is carried aboard the harvester on a continuous belt elevator to a mill, where it is crushed. The resultant sticky, gelatinous mass, deposited in the storage hopper, contains about 80 per cent. of water. This is pumped through a 6-in. pipe. As soon as a capacity load is ready it is transferred by pumps to barges, and thence into digestive tanks on the wharf, each of 50,000 gallons capacity. Subsequent processes deal with evaporation.

PAPER AND PULP INDUSTRY IN JAPAN.

H.M. Commercial Attaché at Yokohama writes that within the past year or two the situation in Japan in regard to the paper and pulp industry has become extremely interesting. The great advance in the price of foreign pulp and the difficulty of obtaining supplies, owing to the war, have stimulated a desire, which is always present amongst the Japanese people as regards their industries, to render this particular industry independent of imported raw material. Extensions of paper and pulp mills have been the result, although it is mainly in the latter branch that extensions have been made. Both in the Hokkaido and Japanese Saghalien, where supplies of timber are abundant, several new mills have been erected and others are projected. A large Japanese paper company has decided to erect a pulp mill at New Wiju (Shingishu), on the Yalu River in North Korea, drawing timber from the extensive forest area in that vicinity, and, in addition, is erecting two

mills, one in Saghalien and one at Ashigawa in the Hokkaido.

In this connection the following particulars, taken from the Report for 1916 of the Yokohama and Tokyo Foreign Board of Trade (*i.e.* Chamber of Commerce), may be of interest: Imports of paper into Japan in 1916 amounted to 36,777,000 lb., as compared with 28,209,000 lb. in the previous year, while the domestic production of paper rose from 367,578,871 lb. in 1915 to 405,468,781 lb. last year. Imports of pulp in 1916 amounted to 57,263 tons, as compared with 53,261 tons in 1915 and 44,983 tons in 1914. The report states that the three plants which are being installed in Saghalien, and which are expected to be in operation by the end of the present year, will produce at the rate of 80,000 tons of pulp per annum. Eventually, it is thought, if these plants, and the projected plant in the Hokkaido, are successful, Japan will become independent of foreign supplies.

OBITUARY.

RUFUS DANIEL PULLAR.—Mr. Rufus D. Pullar, senior partner in the well-known firm of Messrs. J. Pullar and Sons, Perth, died in a nursing home in Edinburgh on the 22nd inst.

The elder son of the late Sir Robert Pullar, he was born in Perth in 1861. He was educated at the University of Edinburgh, where he devoted special attention to chemistry, and he also studied in the Department of Science and Technology in the University of Leeds. He then returned to Perth, and entered the firm which had been established by his grandfather in 1824, and became head of it on the death of his father in 1912. He was greatly interested in scientific pursuits of various kinds, and frequently visited the Continent in order to study the dyeing and cleaning trades abroad. In addition to his business activities he gave up much time to educational and philanthropic work in Perth.

Like his father, Mr. Pullar was a Fellow of the Royal Society of Arts, having been elected in 1906.

NOTES ON BOOKS.

THE WAR AND THE NATION. By W. C. Dampier Whetham, F.R.S. London: John Murray. 6s. net.

Although the end of the war is by no means yet in sight, it is the obvious duty of those not directly engaged in the firing line or the manufacture of munitions, to look forward to the future, and to make such preparation as may now be possible for the day when peace returns to the world, and some of us are already beginning to console ourselves with the blessed word "Reconstruction." To all such we heartily commend Mr. Whetham's volume, for it deals in a thoughtful and forcible way with a great number of the problems which will have to be solved within the next year or two.

The general subject of the book is the consideration of the steps which will be necessary to make good the losses caused by the war, and to meet the enormous burden of national debt which we shall have to face in the future. The particular aspects discussed by Mr. Whetham are treated under six headings: "Laissez-faire," or constructive politics; the land and they that dwell thereon; the organisation of British industry and commerce; coal and railways; the war and the race; and finance and taxation.

With regard to the first section, it is interesting to note that though Mr. Whetham writes as a professed Tory, his Toryism is by no means untinged by Socialism. This combination is no longer so rare as it used to be, and the optimist would like to see in it one of many signs that extremes are at last tending to meet, and that after the war, if parties are reconstructed on the old lines, there will, at all events, be a narrower gulf between them. Not every one of his political opponents will approve of the remedies which the author proposes, but in his desire to improve the conditions of the working-classes they must be at one with him.

There can be little doubt that the war has given its quietus to the policy of *laissez-faire*. The State has been driven, whether it would or no, to take control in many spheres which hitherto in this country were considered sacrosanct to private enterprise; and so great a revolution has been worked in the ways of national thought that it is not likely we shall ever revert to the old conditions. In the matter of education also, far-reaching reforms are imminent, and it is generally recognised that if we are to hold our own in the future competition among nations, we shall have to give the individual every possible chance to show his innate powers of mind or body, and see that he is trained and developed to the best of his abilities, as Mr. Whetham says, in the home and the school, and, if he be worthy, in the university.

Perhaps the most interesting section of the book is Chapter III., which deals with the organisation of British industry and its relation to scientific research. Three years of war have done more than a century of peace to impress upon the public mind the indispensability of scientific research to national prosperity. An important Government Department has been established, with considerable funds under its control, whose sole business is to promote and direct research, and the second annual report which has just been published shows that during the last year it has been far from idle. A large number of important researches have been initiated, and, what is even more valuable, the leaders of British industries have begun to acquire the habit of working together in order to conduct associated researches.

It is impossible to refer in detail to the many points which Mr. Whetham discusses; but it is

hoped that enough has been said to show that his book is a valuable contribution to the chief problems of reconstruction, and that as such it merits the careful study of all interested in the future welfare of the country.

GENERAL NOTES.

Faraday Society.—A general discussion on Pyrometers and Pyrometry will be held at the Royal Society of Arts on Wednesday, November 7th. The provisional programme is as follows: Introductory Address, Sir Robert Hadfield, Bt., F.R.S.; communication from Dr. E. F. Northrup entitled, "High Temperature Production and its Measurement"; Dr. E. Griffiths and Mr. F. H. Scholfield (National Physical Laboratory), "Pyrometer Standardisation." The following papers will also be read: "The Advantage of Burying the Cold Junction of a Thermo-couple as a means of Maintaining it at a Constant Temperature," by Mr. R. S. Whipple; "The Automatic Control Measurement of High Temperatures," by Mr. Richard P. Brown (Philadelphia); "Pyrometry from the Standpoint of Ferrous Metallurgy," by Mr. W. Hatfield; "Base-metal Thermo-electric Pyrometers," by Mr. C. R. Darling. Professor J. O. Arnold, F.R.S., will speak on "Pyrometry Applied to the Hardening of High Speed Steel"; Mr. Cosmo Johns will speak on "Determining the Temperature of Liquid Metals by Means of Optical Pyrometer"; and other speakers will include Dr. J. W. Mellor (Stoke), Mr. H. Watkin (Stoke), Mr. F. Twyman, and Mr. G. E. Murray-Stone (Messrs. Armstrong, Whitworth, Ltd.). Exhibits will be shown by Mr. Richard P. Brown, The Cambridge Scientific Instrument Company, Messrs. Hadfields Ltd., Mr. H. L. Heathcote, Mr. Robert W. Paul, and Messrs. Siemens, Bros. & Co., Ltd. Fellows of the Royal Society of Arts who are interested in the subject are invited to attend the meeting.

Destruction of Insect Pests on the French Riviera.—In consequence of the recent reappearance of the *Icerya Purchasi* amongst the orange and lemon groves and plantations in the Department of the Maritime Alps, steps are being taken by the entomological section of the Ministry of Agriculture to arrest the spread and stamp out the evil. Already many proprietors of gardens have cut down their trees and burnt the wood, probably unaware that less drastic means were at hand by the introduction of the *Novius cardinalis*, the lady bug, which was so successfully employed for the purpose in this neighbourhood only a few years ago.* Steps are now being taken by the phytopathological service of the Ministry of Agriculture to establish at Menton an *Insectarium*, where not only the *Novius cardinalis* will be reared but supplied gratis, together with advice to all applicants. Anybody doubtful of the identity of any particular insect that may be found on his property is requested to send specimens without delay to Menton, where special boxes for the purpose can be obtained, together with advice, without charge.

* See *Journal*, Vol. LXI. p. 756, "The Destruction of Insect Pests in France."

Banana-growing in New South Wales.—The cultivation of the banana, according to the *Fruit World of Australasia* (Melbourne), is extending rapidly in the districts of the Tweed and Brunswick rivers. Orchards of commercial importance planted with the Cavendish variety, which is much superior to the ordinary banana in quality and aroma, are found chiefly at Terranova, Piccabun, Bilambil, and Cobaki. Three hundred to four hundred plants are grown to the acre, and the plantations are usually from ten to twenty-five acres in extent, though some are much larger. The first crop of one cluster of bananas per plant is gathered from sixteen to twenty-four months after planting; the following year the crop increases to four or five clusters per plant. In 1915 the crop from one plantation at Bilambil was valued at £2,320, a gross return of £232 per acre. The cost of planting one acre with four hundred banana trees varies from £10 to £14 10s., according to the price of plants, which ranges from £1 12*s.* to £2 8*s.* per hundred. Land suitable for banana-growing costs from £29 to £54 per acre, and plantations in full bearing are valued at about £96 per acre.

Minerals in the Philippines.—A serious effort is being made to develop the coal and iron deposits in the Philippine Islands. In the province of Surigao, Mindanao Island, there is, close to the shore and easily workable, a known deposit of high-grade ore with an estimated yield of over 500,000,000 tons. There are other deposits in numerous places, says the *London and China Telegraph*. So far the comparatively small quantity of native coal mined has been inferior in quality to coal of China, Japan, or Australia. It is expected, however, that development of the most promising field will produce a satisfactory grade. In 1916 the Philippines produced for export 103,256 ounces of gold, an increase of 13,573 ounces over the 1915 record. There is promise of steady increase in gold production for many years to come. The outlook for transportation is also encouraging, and it was recently reported that a British line of steamers intended to run large modern steamers between Vancouver and the Far East to supplement the existing services. It is also stated that the Norwegian shipping concerns contemplate sending some of their vessels to secure Philippine trade.

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FRIDAY, OCTOBER 5, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

THE SHORTAGE OF THE SUPPLY OF NON-PHOSPHORIC IRON ORE.*

By William George Fearnsides, M.A., F.G.S., M.Inst.M.E.,
Sorby Professor of Geology, University of Sheffield.

Lecture I.—Delivered April 30th, 1917.

(*Continued from p.* 754.)

Geological Distribution of British Iron Ores.

Considering the various geological formations in order of their age, we note that among pre-Carboniferous formations in the British area there is a remarkable absence of any considerable concentration of iron ore. Of great pre-Cambrian magnetite masses similar to those in Sweden—presently to be discussed—we have no representative, neither have we any formation at all like the pre-Cambrian specular hæmatites and quartz-hæmatite schists of the Lake Superior region of America.

Our Cambrian sediments, though often having a good deal of both ferrous and ferric iron in their composition, have neither bedded deposits nor veinstones worthy of the name of iron ore, and where under exceptional circumstances lenticles of pisolitic limonite are developed along the thrust-planes which traverse them, these (as at Bettws Garmon, Tremadoc and Dolgelly) are too small—and too sulphurous—to be of more than local interest. Ordovician and Silurian rocks in Britain are similarly deficient in concentrations of iron ore, and though the ferruginous Llechwedd Erwent Limestone of Arenig, in North Wales, presents similarities to the *Calymene* ironstones of Normandy and Brittany, no attempt has been made to work it.

South of the Bristol Channel, Silurian rocks, and, to a more marked degree, Devonian rocks, are intersected by mineralised veins which, in the neighbourhood of the post-Carboniferous granite masses, carry magnetite and hæmatite, and, further away, bear manganiferous siderite; but the smallness and impersistence of the ore bodies and the difficulty and cost of transport to the coal have prevented any considerable development of iron-mining in that region. The hæmatite veins which traverse the older Palæozoic rocks of the Lake District and pass up into the Carboniferous Limestone of Cumberland and Furness are also of similar post-Carboniferous age. In considering the Carboniferous Limestone of the whole country, it is notable that neither in the Pennines nor in Ireland, where there is a great spread of limestone rock apparently like that of Cumbria, is there any sign of lodes carrying hæmatite, and it appears as if the veins which bear the hæmatite are limited to a narrow belt of country which ranges magnetic north and south through West Cumberland and the Forest of Dean. The spathic siderite veins of the lead district of Durham and East Cumberland, which have the interbedded limestone and shale series of the Yoredale as their country rock, seem to flank the hæmatite lode region, and the same interrelationship may well hold between the siderites among the Devonian of the Brendon Hills and the hæmatites of the Forest of Dean and South Wales. The ironstones of the Lower Coal Series of Scotland, as also those interstratified with true Coal Measures in every coalfield of Britain, were deposited in water-logged marshes during the Carboniferous epoch, when, for almost a whole geological period together, the rhythm of isostatic conditions particularly favoured the segregation of iron from the mass of muddy sediment into thin ironstone bands. Generally, except in the northern

* The course consisted of two lectures, delivered on April 30th and May 7th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into three parts.

part of the English Midlands, the individual beds are too thin to tempt exploitation under present economic conditions, and are only worked where they must needs be disturbed in the getting of the coal.

Above the Carboniferous, neither the Permian nor the Triassic formation has any interbedded deposit worthy of the name of iron ore. Usually, however, they show a very prevalent hæmatite red staining; and where, in the neighbourhood of the West Cumberland-Forest of Dean belt of hæmatite veins mentioned above, their basal conglomerate rests upon the Carboniferous Limestone, the staining is in places so intense, and has so much the character of a general impregnation, that locally the rock is worth working as a low-grade iron ore.

With the Jurassic rocks we have, perhaps, dealt in sufficient detail, but in recapitulation it may be mentioned that nowhere along the great Jurassic outcrop between the coast of Dorset and the Cleveland Hills is there any district of which it can be said that there is lack of iron ore. About the Humber the Lower Lias carries the ore-bed. Usually, as in Cleveland, Leicestershire and Mid-Oxford, it is the Middle Lias which is the most prolific. In Northamptonshire and in the extreme south of the Cleveland district (Rosedale) the basal member of the Inferior Oolite has the most massive development of iron ore. It is significant that the only new discoveries of workable iron ore within the British Isles put on record since 1880 have been in the Middle Lias of the Island of Raasay, and the Corallian ironstone traversed when sinking to the Coal Measures in Kent.

Belonging either to the topmost beds of the Jurassic or to the lowest sub-division of the Cretaceous Series, are the ironstones which in former days supplied the active charcoal-iron industry which in mediæval times flourished in the forest district of the Kent and Sussex Weald, and lingered at Ashburnham in Sussex until 1824. In quality and manner of occurrence these Wealden ironstones are hardly to be distinguished from the clay-ironstones of the Coal Measures, and though on the average the individual beds are a little thicker than the majority of the bands in the Coal Measures, it seems unlikely that under present conditions they will bear the cost of mining and transport to any but a local supply of coal. A little higher in the Cretaceous Series, the Lower Greensand beds (Neocomian) have been worked in Lincolnshire, in Wiltshire, and in Bedfordshire in fairly recent times, but have been abandoned as yielding too silicious an ore. Over considerable areas about Selham in Sussex weathered glauconitic sands, in places many yards in thickness, enriched with derived detrital ironstone, seem to tempt the development of a smelting process which will make use of them, but the metallurgical problem involved is not yet solved.

Among the Tertiary formations in England there are no considerable concentrations of iron ore, and though the area within the Antrim plateau of North Ireland over which the bauxitic limonites extend is considerable, economic conditions—more especially the difficulties and cost of transport to furnace of material which is not high-grade—do not appear to favour any present increase of the rate of their exploitation.

In fine, therefore, just as the Carboniferous is the great repository of Great Britain's fuel wealth, so the Jurassic is the bank which holds our fluid reserve of iron ore. The gilt-edged securities of Cumbrian hæmatite are sound, but not unlimited in amount; while the market for the vast quantities of the clay-band and black-band ores of the Coal Measures is so limited that as a security they must needs be written off. Our engineers prefer the produce of the hæmatite, but there is a shortage, and the price is therefore high. There is plenty of the low-grade phosphoric ore available and cheap. Surely it is not beyond the skill of our metallurgists to make use of it, and obtain from it a product which on its merits will overcome the prejudice of the British engineers. This is the only domestic solution of the problem of the home shortage of non-phosphoric iron ore.

Lecture II.—Delivered May 7th, 1917.

INTRODUCTION.

In the course of the former lecture it was the object of the author to present a conspectus of the relative importance of the various iron-fields where ore production is in progress within the British Isles, and in general terms to emphasise the availability of abundant home supplies of cheaply-workable, if low-grade, Jurassic ore. To-day our purpose is different, and we have to pass in review the various ore-fields in foreign countries, which, under peace conditions, send produce, either raw or semi-manufactured, from their iron-mines to supply the British market, or are at present endeavouring to export it westward, if only through the cannon's mouth.

That the quantity of iron brought by ship to Britain has for twenty years past been in excess of the quantity wrought in British mines and quarries, is a fact that appears to have been realised by few; although, in the official publications of the Home Office, the graph illustrating the almost continuous increase of imports of foreign ore which has been in progress since the middle seventies, has yearly been reprinted for all to see. Imported ore, having to bear the cost of freight as well as the cost of getting, is generally a fine, selected, high-percentage ore, while in the average of the home ores, as we have already seen, the percentage is compulsorily low. Moreover, with the abandonment of working of Coal Measure ores as too expensive, the tendency of the percentage of metallic iron contained in the home ores worked has been continuously down, and in the last twenty years has degraded from 34·7 to 32·1, while in the ores from overseas the iron percentage, always high, has during the same period suffered no appreciable change. When these important factors are allowed for, and the weight of pig-iron yielded is plotted alongside of the yearly tonnage of iron ore (Fig. 1), it becomes evident that since the beginning of the present century the supply of foreign ore to British blast-furnaces has been almost as important as the home supply, and when, to the weight of pig-iron made from foreign ores smelted within the country, is added the weight of metal which the country has imported in the semi-manufactured state (in 1913 the quantity was 2,323,173 tons), ample proof is afforded of the seriousness of the situation, and of the dependence of Great Britain upon ironfields overseas.

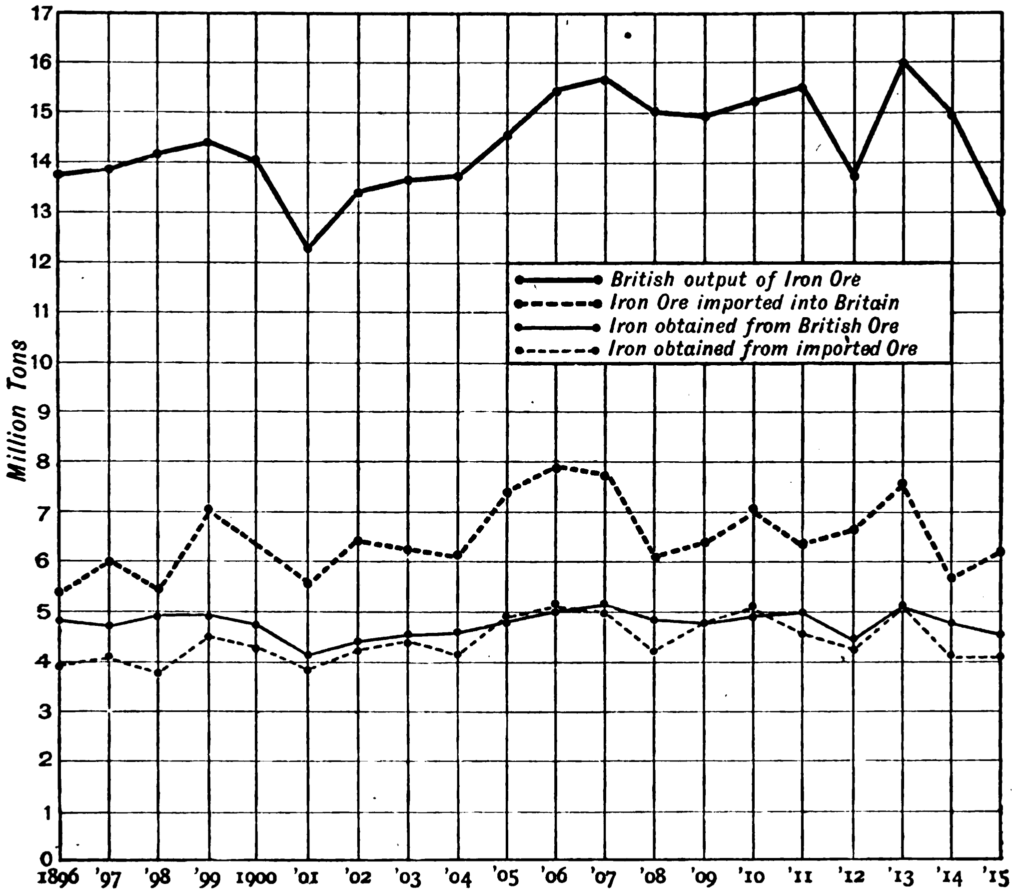

FIG. 1.—CURVE SHOWING BRITISH OUTPUT OF IRON ORE AND IRON OBTAINED FROM BRITISH AND IMPORTED ORE.

In the former lecture considerable emphasis has been laid upon the change which was effected in the *locus* of home iron-ore production

when the place of wrought-iron in railway and ship construction was taken by Bessemer and open-hearth steel. The manufacture of steel by the Bessemer process dates back to 1856, and open-hearth steel was first made by the Siemens-

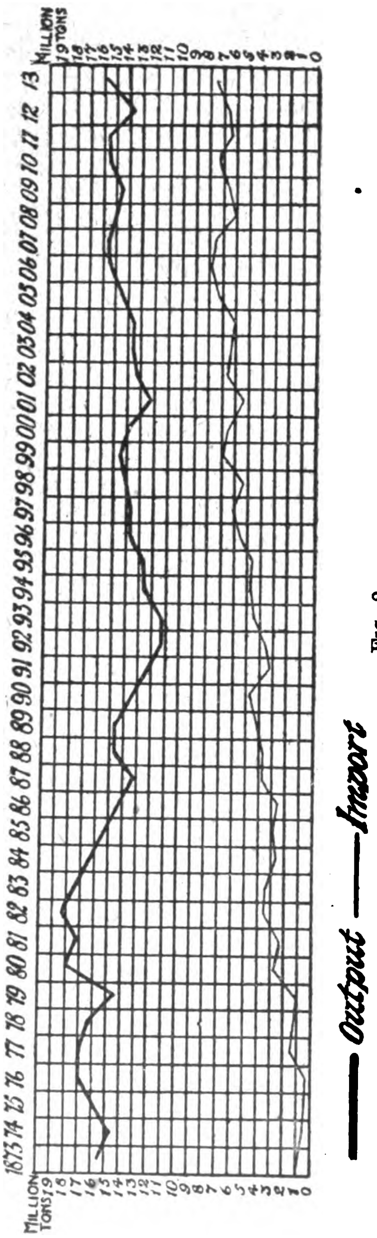

Fig. 2.

Lent by H.M. Stationery Office.

Martin process about 1868, but neither of these methods became commercially effective until the eighties had begun. For both these processes, which at first were only successful when carried out in vessels lined with "acid"—*i.e.* siliceous—materials, pig-irons made from non-phosphoric ores were required, and the demand for ores like the hæmatites of Cumberland suddenly increased; and even though the output from the mines of Cumberland and Furness was just rising to its maximum, a national shortage of home supplies of hæmatite was soon acutely felt. That shortage was met by importing more hæmatite ore from Bilbao, and the import trade in Spanish hæmatite rapidly grew to considerable dimensions. From quarries not far from the sea-board of a country which is chronically short of coal, blast-furnaces sited on the seaward side of the great coalfields of Scotland, South Wales and Durham were able to import this foreign ore at prices which proved to be advantageous, and the continuous upward slope of the import line on the graph (Fig. 2) is a record of the financial success of the operations involved.

Expressed in figures for the year 1913, the position may be set out as follows: Whereas the cost of turning just under 16 million tons of British ore into 5·1 million tons of pig-iron was 17·1 million pounds, the cost of turning 7·4 million tons of imported iron ore, *plus* ·6 million tons of "purple ore," *plus* an undetermined (small) amount of scrap steel turnings and of mill cinder, into 5·1 million tons of pig-iron, was just less than 15 million pounds, a net advantage in favour of the foreign ore of 2·5 million pounds. The cost of the British ore at mine was 4·5 million pounds, and the cost of the foreign ore as delivered at British port was 7 million pounds, between which figures there is also a difference of 2·5 million pounds. The difference in cost of manufacturing the home and the foreign ore is therefore approximately equal to the difference between their purchase prices, and we may infer that the price which the British market has in recent years paid for its continued preference for "acid" hæmatite iron smelted from foreign ores as against "basic" iron made from home ores is the cost of the essentially foreign "purple ore" *plus* the value of the mill-cinder and the steel turnings used.

As the demand for Spanish hæmatite has grown among our ironmasters, so among their rivals of the Rhineland the virtues of this particular grade of materials has not been overlooked, and as the years have gone by the large resources of the Bilbao district—to which a short sea passage and reasonable facilities for loading gave a long initial advantage over other districts—have proved neither illimitable nor even sufficient to fulfil the needs of the European markets in the pre-war years. In consequence of

this shortage, the centre of hæmatite supply showed signs of a gradual shifting southwards and eastwards, and already almost all the coalless countries around the Mediterranean have been drawn upon to supply hæmatite to the great fuel-producing areas which adjoin the North Sea. With ample shipping tonnage available at reasonable rates, it would appear that for several decades to come the Mediterranean countries should be able to keep up the hæmatite supply, and though rising demand and freights consequent upon an increasing length of sea passage are likely to secure a continuously upward trend of prices, the first call on the more distant sources of supply is and will remain with the maritime nation which wields the trident of sea supremacy.

Troubled, and perhaps spurred on to alternative action by the difficulties of securing continuous supplies of hæmatite by ship, the ironmasters on the south-eastern side of the North Sea early turned their attention to the metallurgical problem of substituting for it ores which are abundant within their own Zollverein. Soon they adopted the process (invented in 1877 by Sidney Thomas and Percy Gilchrist) which was the British East Coast ironmasters' first answer to the call for Bessemer and open-hearth steel in place of Cleveland puddled iron. Gradually improving the technique of this "basic" process, and meeting no active commercial competition in the markets where they bought their ore, the efforts of German and Belgian ironmasters have during the present century met with a large measure of success. So long as the basic steel industry of the Rhineland was in its infancy and youth, the Jurassic ironfields of Luxembourg, German Lorraine and Belgium produced sufficient output to keep its furnaces fed, but as it has passed from adolescence towards maturity the hungry steelworks have called for supplies ever more and more abundant, and the net has been cast more widely over many adjoining countries. First French Lorraine, then Swedish Lapland and Northern Norway, and later Poland and even Western France, in the pre-war years, successively were brought effectively under the control of powerful German financial syndicates, which, having established for the Rhineland what in effect was an European monopoly of basic steel production, were anxious to safeguard that monopoly and to be ready to stifle competition for reserves of raw materials whenever and wherever that competition might arise.

What surprises the metallurgists of the future have in store for steel producers can hardly be foreseen, but if the output figures for the last decade may be taken as a true indication of changes which are actually in progress, it seems quite probable that, just as the expense of mining the "clay-band and black-band" ores of the British Coal Measures has since the eighties curtailed their output until they are no longer used for purposes which Jurassic ores can be made to serve, so a time is coming when hæmatites obtained from scattered ore bodies, and bearing increasing costs for freightage, will be unable to compete against the large and cheaply worked bodies of phosphoric ore which occur in districts more convenient to the coal.

The balancing of the price of metallurgical processes of refining against ever-increasing transport costs is a matter of considerable national importance, and it is with this point of view before us that we shall discuss the overseas ironfields from which the British market is supplied.

OVERSEAS IRONFIELDS WHICH SUPPLY THE BRITISH MARKETS.

Following the plan adopted in the former lecture, we may tabulate the countries in the order of the tonnage of ore which in 1913 was shipped to this country through their ports as follows:—

TABLE SHOWING THE QUANTITY OF IRON ORE IMPORTED INTO BRITAIN, 1913.
By Countries.

Country.	Iron Ore.	Manganiferous Iron Ore.	Cupriferous Iron Pyrites.
	Tons.	Tons.	Tons.
Spain	4,525,843	188,196	559,910
Algiers	759,461	3,797	—
Norway	487,799	—	133,925
Sweden	366,691	—	—
France	327,234	—	30
Tunis	279,071	—	—
Greece	203,643	13,499	—
Newfoundland	100,346	—	9,526
Portugal	—	—	75,993
Russia	75,294	—	—
Netherlands	27,330	—	—
Belgium	23,155	—	—
Chile	13,778	—	—
Canada	11,542	—	—
Italy	10,853	—	—
Germany	10,387	—	—
Asiatic Turkey	3,542	—	—
Other countries	4,636	6,152	827
Totals	7,230,605	211,644	781,711*

* This imported cupriferous iron pyrites, after treatment at sulphuric acid and metal extraction works, is estimated to yield 586,283 tons of purple "ore."

As, however, these tabulated figures refer only to raw ores, and take no account of the ore which in overseas countries is reduced to metal and in that form exported, they cannot be considered as indicating the real order of importance of the ironfields to the British market until some correction, which includes the weight of metal entering the country, has been applied.

In 1913 the countries which sent the greatest weight of semi-manufactured metal to Britain were:—

Germany	1,198,296 tons
Belgium	585,446 „
Sweden	209,687 „
U.S.A.	155,905 „
France	42,227 „
Netherlands	11,221 „

To attempt to trace back to the place of its ultimate origin in the ironfields material which arrives in this country as smelted metal is a task beyond the scope of the present paper, and recognising this difficulty, as also the circumstance that both smelted metal and ore not infrequently are shipped through the ports of countries in which they do not originate, it has been thought well to consider the various ironfields in their broad topographical (*i.e.* geological) groupings, without laying too much stress upon the political boundaries between the separate countries.

The Iberian Peninsula.—In quantity of ore exported to meet the needs of British furnaces there is no overseas region which can compare with Northern Spain. First opened to provide iron ore for export in the early sixties, the quarries in the northern foothills of the Cantabrian mountains did not attain an annual output of a million tons until 1878. But when the demand for non-phosphoric hæmatite was increasing, and could no longer be met by the produce from Cumbrian mines, British capital was enlisted in their development, and the output of Spanish hæmatite increased to over five million tons in the early nineties, and to almost twice that figure in 1907. During the last decade many of those ore bodies close to Bilbao, which were opened up in the eighties, have been exhausted, and only by improved methods of working and mechanical dressing of the leaner "chirta" ores has the output from the Viscaya district been prevented from falling off considerably.

The ore bodies of the Bilbao district belong to the metasomatic class and occur in association with the massive *Requina* limestone, which is equivalent in age to the Gault or to the base of the English Chalk. In depth they include a good many kernels or nuclei of *siderosa* or spathic siderite, from which the *vena* and *campanil* (hæmatite), as also the more superficial hydrated *rubio* (limonite), seem to have been derived by surface weathering and the leaching out of soluble salts. The Bilbao ore belt extends from the banks of the Nervion River to beyond Somorrostro in the province of Santander, and wherever in this district the minor synclines which flank the major mountain folds of the Pyrenees have included and protected the limestone from complete denudation, there the ore bodies were developed. The form of the individual ore masses is on the whole lenticular, but there are many irregularities where the solutions responsible for the metasomatic alteration process have followed the course of the various faults, joints, or bedding planes which break up the limestone rock. The largest of the ore lenticles of the district is that which formed the slopes of the Triano mountain, on which hill it was worked to a thickness of over 200 ft., and proved continuous over a length of more than two miles with a maximum width of outcrop of about one mile. The ore body of Metamoros, which adjoins that of Triano, was hardly less extensive.

In recent years it has been found profitable to wash the hill rubble which litters the lower slopes and alluvial flats in the neighbourhood of the main ore lenticles, and by this process the somewhat siliceous ores exported to Westphalia as "chirta" were largely obtained.

The quantity of ore exported from the Bilbao district since 1880 exceeds 180 million tons. At its pre-war rate of depletion the known ore reserves could hardly have been expected to last beyond another decade.

As the exhaustion of Bilbao has proceeded, attention has gradually been turning to other parts of Spain, and valuable metasomatic replacements of Cretaceous limestones have been discovered at various other places along the Spanish Pyrenean chain. In the districts of Oviedo on the north and Lugo and Leon on the south, very promising ore bodies wait only for better means for transport of ore to seaboard to come into bearing on an extensive scale. In South Spain also, despite the longer passage to North Sea ports, the present century has seen the beginning of active development of ironfields, in the provinces of Almeria, Murcia, Guadalajara, Teruel, and Sevilla, whence a growing annual output—in the pre-war year more than half

that from Bilbao—has been exported. There is considerable proved reserve of hæmatite associated with the unconformity at the base of the Jurassic system in these central and southern Spanish provinces, and if the quality is not identical with the best "campanil" or "rubio," it is good limonite or hæmatite low in

The large quantities of cupriferous iron pyrites noted as imported from Spain, and also from Portugal, come from the district of Rio Tinto and San Domingos, traversing the southern end of the international border west of Huelva. They occur in association with igneous rocks (porphyries and porphyrites)

Iron-ore Producing Areas in Countries adjoining the Western Mediterranean.

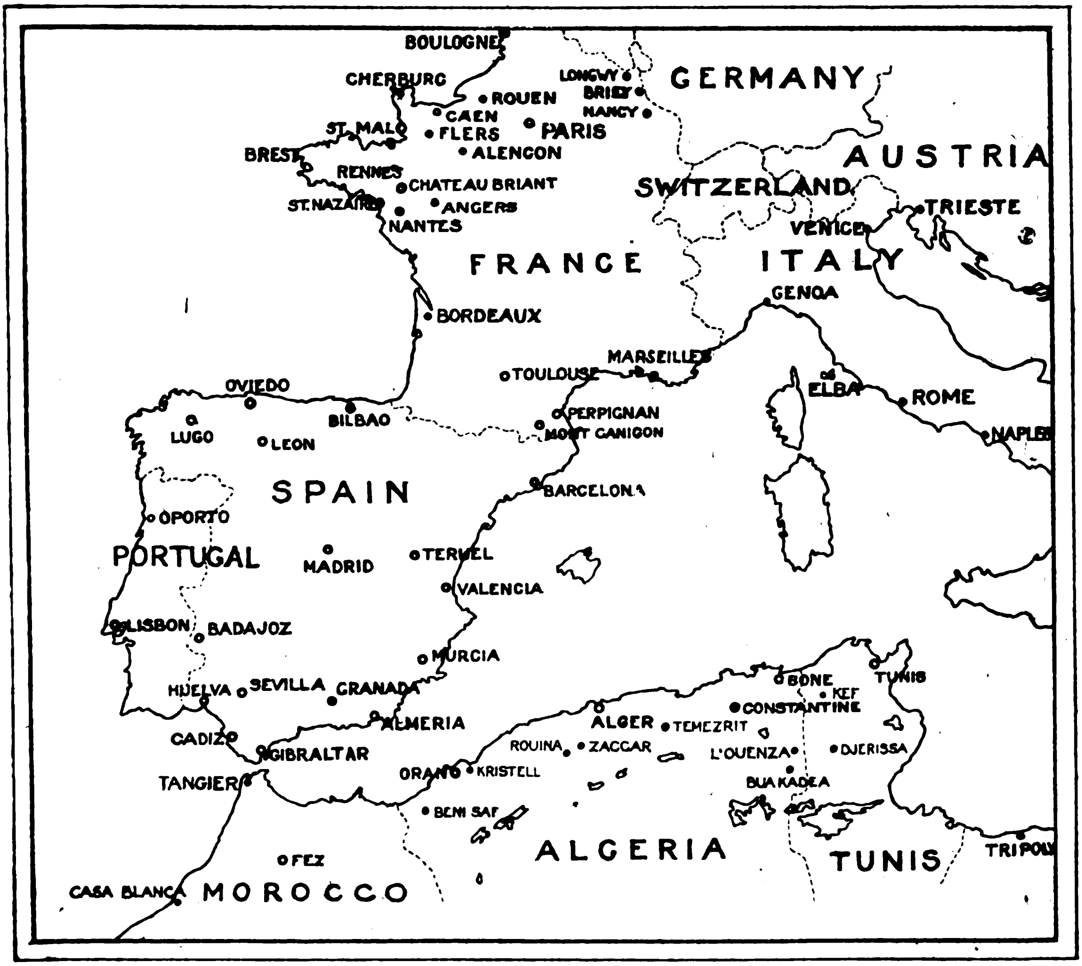

Fig. 3.

phosphorus and sulphur, and contains over half its weight of metallic iron. In other parts of Spain—*e.g.* the district of Marbella in Malaga—the ancient crystalline (Pre-Cambrian ?) rocks include lenticles of magnetic iron ores which are even richer in iron than are the hæmatites, but as yet there are no railways to carry them to seaboard.

traversing the clay slates of the Culm series of the Carboniferous, and are regarded as "magmatic" intrusions. Pyrites of this class is imported to this country primarily for sulphuric acid-making, and for the metals other than iron (*i.e.* copper, silver, gold, and platinum) which it contains, and it is only when the chemical manufacturers and metal extractors have done

their worst with it that it is handed over to the ironmasters in the form of "purple ore." By that time it consists principally of hæmatite, and has lost about 25 per cent. of its weight.

The manganiferous iron ore is used for making spiegeleisen. It is generally mined as spathic carbonate from metalliferous veins, and is shipped to this country through the ports of Southern Spain.

It was estimated in 1910 by Vidal that there is over 700 million tons of iron ore, containing almost half its weight of metallic iron, ready for working under existing economic conditions within the various provinces of Spain. The maximum quantity of iron ore purchased by this country from Spain in any one year was in 1906, when 5,949,000 tons were imported.

Lorraine.—In contrast to the raw hæmatite, manganiferous iron ore and cupriferous pyrites which are sent direct from Iberian mines to feed the blast furnaces of this country, and are recorded ton by ton in the import returns, the produce from the Minette orefield of Lorraine, which is smelted and converted into manufactured or semi-manufactured metal in the furnaces of Germany, Belgium, France, or Holland before it arrives, is not separately recorded, and as a source of supply to British markets the importance of the orefields of Lorraine is therefore often overlooked. When, however, we consider that over three-quarters of the German iron-ore output, and nearly nine-tenths of all the iron ore produced in France, is won within ten miles of the pre-war Franco-Prusso-Belgian border, and that neither in Holland nor in Belgium is any quantity of iron ore worth mentioning produced, it is evident that of the 1,837,900 tons of semi-manufactured metal which was imported in 1913 from the four countries, a very considerable proportion—certainly far more than a million tons per year—could be traced back to a source of origin in Lorraine.

Since in the smelting of each ton of metal at least three tons of Minette ore and hardy less than two tons of coal is consumed, it must follow that in 1913 for tonnage of mineral mined to supply the British steel market, the region which includes the ironfields of Lorraine and also the Hercynian belt of coalfields of the Saar basin, Rhineland-Westphalia, Belgium, and Artois in Northern France must have held a place equal to, if not in front of, the ironfields of Spain.

The iron ore wrought in Lorraine occurs as a series of beds interstratified among the shales and limestones of the Jurassic series at a horizon (Toarcian) which geologically is almost identical with that of the Northamptonshire iron ores just where the Upper Lias is passing into the Inferior Oolite (or Bajocian) series of the Middle Jurassic. The outcrop of the ironstone extends from the southernmost tip of Belgium, through the borders of Luxembourg with France and German Lorraine, southward at an average distance of about three miles inside the German border as far as Metz, and crosses into France just east of Nancy. It is estimated that of the workable orefield about 160 square miles lies on the German side of the border, 14 square miles in Luxembourg, and that on the French side about 208 square miles can be worked at a profit under a thickness of cover which, in a direction southwards and westwards, increases to about 1,000 ft. in ten miles.

Within the ironstone formation some half-dozen individual beds are distinguished according to their colour, which appears to vary with the percentage of silica which the rock contains. A Lower (siliceous) group, green or dark-coloured, is overlain by a Middle (calcareous) group which has at its base the "Grey Bed," which is most in demand, and passes upwards through red beds into the sandy beds which form the Upper group or "hanging wall." Over a wide area the workable thickness of the Grey Bed averages 10 ft., and of this and several other individual beds it is recorded that locally their thickness exceeds 24 ft. The iron mineral is generally present either as limonite or as ferrous carbonate, which forms the successive coatings of spherical or ovoid oolitic grains. Crystalline calcite is often present in the matrix between the oolitic grains, and sand particles as well as shell fragments are frequent as nucleï on which the oolitic coatings are built. The occurrence of Grünerite, a hydrated silicate of iron, is also recorded from the deeper pits. On the whole, the ores of the Grey Bed, though less argillaceous and more limey, resemble more closely the Liassic ores of Cleveland than the ores of Northampton, which are more nearly contemporaneous with them. From many of the mines working this Grey Bed the ores are almost perfectly self-fluxing, and when the pig-iron is run from the furnace its composition is so favourable for the application of the Thomas process of refining that a very little manganese "for fluxing" is all that need be added during its conversion into steel. Ores of the siliceous group require a good deal of added limestone for their

fluxing in the blast-furnace, and are at present only worked extensively where fully oxidised in the neighbourhood of their outcrop.

For a detailed account of the resources of the Lorraine district from the French point of view, one may refer to the paper presented by M. Nicou to the Iron and Steel Institute in 1914, and for an accurate map to that prepared by M. Villain for the International Geological Congress at Stockholm in 1910. According to German authorities, quite the best ore obtainable from the whole region comes from the deep

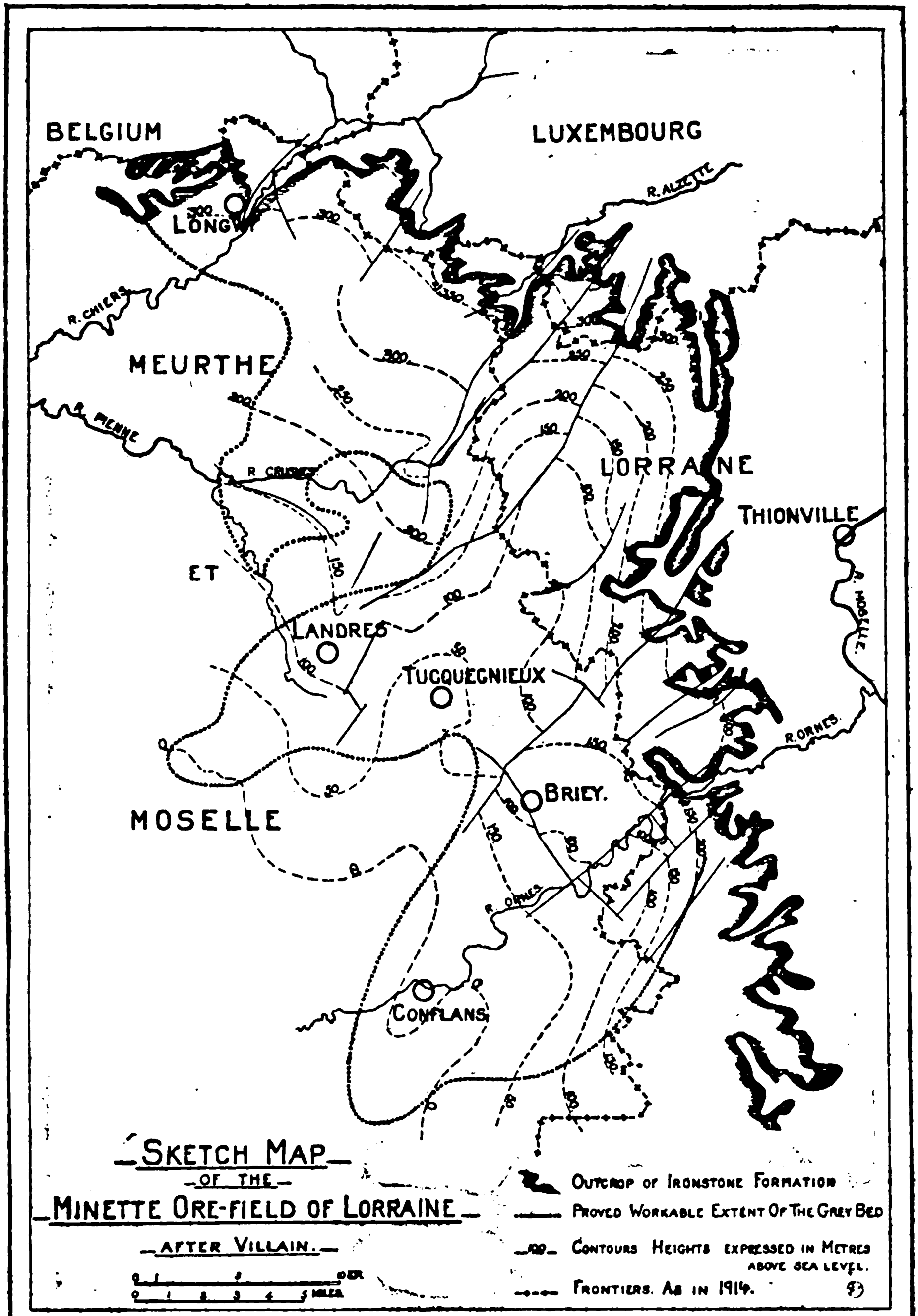

FIG. 4.

mines working beneath the Briey plateau, and apparently, were not the German ironmasters bound to continue their payment of royalty to the owners of the minerals in German Lorraine and Luxembourg, they would have abandoned the workings near the outcrop, and bought in as much ore as possible from the Briey mines. By 1913, despite the old commitments and the more considerable distance which separated the minefields from the coal, the German ironmasters had, under the Republic, become owners of 15,000 acres of iron-ore concessions in French Lorraine, and were yearly importing from that district into Germany almost three million tons of Briey ore. The rise in the importance of the Briey mines is shown by the figures for annual output which, from 313,000 tons, or 7 per cent. of the total French production in 1900, grew to 15,147,000 tons, or over 70 per cent. of the total French output in 1913. The basins of Longwy to the north and Nancy to the south contributed a further 20 per cent. to the French output.

The opening-up of quarries and mines along the Minette outcrop in Belgium and Luxembourg dates back to about 1860, and those of German Lorraine to the years which followed the war of 1870–71, but it was not until the late eighties and nineties that, with the perfecting of the basic process, the district showed signs of establishing itself as the source of the cheapest supply of steel in Europe. The main difficulty in still further extending the steel industry which takes its iron-ore supply from Lorraine is the distance which separates the ironfield from an adequate supply of coke, and the consequent transport charges which the metal made from its ores must shoulder. The source of supply of fuel most convenient to Lorraine is the coalfield of the Saar, which lies only some fifty miles to the north-east. By the canalising of rivers and, where necessary, the building of canals across the watersheds, much has already been done to minimise the cost of transport to the coalfields of Westphalia, Belgium, and Artois, 100 miles to the northward and on the further side of the Ardennes; but a great deal more will have to be accomplished before it becomes economical to carry cargoes of even the best 40 per cent. Fe. Minette 200 miles to port, and send it thence—even as ballast cargo—to England for barter in return for coal.

In the pre-war year the output from the whole Minette field could not have been much short of 50 million tons, and it may fairly be estimated that during the last forty years over 700 million tons, out of a total proved reserve of about 5,000 million tons, of Lorraine ores have gone to furnace. The Belgian area is exhausted. From the Luxembourg area approximately 180 million tons, or nearly half the payable ore, has been already got. From German Lorraine about 300 out of about 2,000 million tons, and from France over 200 out of something less than 3,000 million tons proved is won.

Truly the Lorraine iron-ore district is an asset of the highest national importance, and there can be no doubt that, when official Germany has allowed rumours of her arrogant peace terms to be bruited, the industrialists of the Rhineland are at one with the military caste of Prussia in classing Briey and Longwy as essential strategic points.

(*To be continued.*)

THE FORESTS OF BRITISH COLUMBIA.

In the course of a paper on "The Economic Resources of British Columbia," by Dr. J. F. Unstead, in the *Geographical Journal* of August, the following particulars of the forests of the province are given:—

At the present time the forests of British Columbia form the most important of the natural resources if these are judged by the annual value of the products.

Particularly in the southern half of the province, where the mild climate is combined with the abundant rainfall of the coast, there is an extraordinarily dense growth of timber, and again where the rain is adequate on or near the western slopes of the Rocky Mountains a less dense but still valuable growth is found. Over much of both these areas the slope of the ground is so considerable that forestry is likely to remain the chief industry, though in particular districts mining and agriculture will assume greater importance. On the plateau, the semi-arid climate permits only a light growth of timber, and forestry will not become as important; grazing and agriculture will then form relatively greater, if not highly productive, resources.

The fact that so much of the best timber grows in the coastal regions and that the coast is penetrated by fiords to an unusual degree gives British Columbia a great advantage in marketing the lumber, and this advantage is increased by the fact that in these regions the "stand" or growth of timber per acre is exceptionally great, while the climatic conditions allow the work to be continued throughout the year. Moreover, much of the timber lends itself to the production of pulp and paper, a branch of the industry which is of growing importance, and the pulp mills find abundant water-power from the mountain streams. Yet in comparison with the large areas of forest thus

favourably situated, the districts over which logging is now carried on are small, being distributed mainly along the adjoining coasts of Victoria and the mainland, and in the neighbourhood of the Kootenay, Okanagan, and Arrow lakes. The lumber obtained during the year 1913 was 1,200 million feet* from the coast region and 400 million feet from the interior.

The total forest resources of British Columbia have been variously estimated, but the most trustworthy statements are those of the Forest Branch of the Department of Lands. The following is a quotation from the Report of 1912: "There are in the entire province over 100 million acres of timber land, of which about 65 million acres possess a topography and soil which will permit a production of merchantable timber, which eventually, when transportation means become available, can be profitably logged . . . The annual production of these 65 million acres of forest land would be, under proper management and protection, certainly no less than 6,500 million board feet, and as utilisation grows closer, greatly in excess of this amount." The reports for the next two years state that further surveys have been made which confirm these estimates. This computation deals only with the lands that are useless for agriculture or grazing and may be regarded as purely forest areas.

The methods of logging are being greatly improved, so that the forests as a whole are conserved and may be thought of as a source of wealth that with proper management may be indefinitely utilised. Therefore it is not merely the present stand of timber that must be taken into account, but also the rate of reproduction; it appears that owing to the warm and moist climate with a long growing season the rate of growth of the trees in British Columbia is twice as great as the average for the whole of North America. The only definite statement upon which the Forest Branch has ventured was that in 1912, before the forests were adequately protected from fire or from methods of cutting which retarded reproduction, the annual growth over the whole of British Columbia was not less than five times the annual cut in the areas at present utilised.

Therefore, with the present methods the industry may increase at least five-fold and yet be prolonged indefinitely. But elsewhere the Forest Branch complain of the waste in the present methods of cutting, and say that not more than 40 per cent. of the timber logged over is actually used. It cannot be doubted that a considerable proportion of this waste may be avoided, particularly when the low-grade material is utilised for by-products, such as wrapping paper, that may be profitably made from the saw-mill waste, and turpentine, wood-alcohol, tar-oil, pitch, and resin.

Thus it appears: (*a*) that without entrenching upon the permanent store of forest wealth the cut of 1912, *i.e.* 1,330 million feet, may be multiplied by a factor not less than 5; (*b*) that if the waste is diminished by one-third and the proportion of timber actually used is increased from 40 per cent. to 60 per cent. of the amount cut, the net production may be estimated by raising this factor of 5 to 7½; (*c*) that if the measures taken to ensure more complete and more rapid reproduction increase the rate of new growth by one-fifth this factor will became 9. However, to guard against an overestimate, a factor of 8 is here taken, and therefore the permanent yield of the forest may be estimated at 8 times the yield in 1912, and an annual cut of about 11,000 million feet may be regarded as possible.

According to the census returns of 1911, a cut of about 1,200 million feet afforded work for 25,000 men directly employed in the logging camps and in the saw and shingle mills, and therefore it may be anticipated that with a cut of 11,000 million feet, 230,000 men may be directly employed in the timber, wood, and by-product industries, if the natural resources are fully utilised.

* The volume of timber is reckoned in terms of the length of planks 1 ft. wide and 1 in. thick which could be cut from it.

THE CHINA CLAY INDUSTRY OF CORNWALL AND DEVON.

One of the important markets for China clay is the paper-making trade. Upon the world's consumption of paper largely depends the production of China clay in normal times. At various periods the demand grew more rapidly than the ability to supply. China clay was carried from Cornwall and Devon to every continent in both hemispheres. From August, 1914, when the European war commenced, to the present time, the China clay trade has been affected with a varying effect and consequence. During the early months of the war, the absence of the German and Austrian markets was to some extent compensated for by demands increasing from other countries. During 1915 and 1916 various Governmental restrictions with regard to tonnage and to exports and imports connected with the manufacture of paper reduced the demand for China clay. While this demand was more limited, however, the depletion of labour from the clay pits and other causes led to a greatly reduced output of China clay. This smaller production, with the enhanced value of coal and other materials, together with higher wages, added considerably to the cost of the finished product. As demand and supply kept somewhat level, it was thought unwise or not possible to obtain from the consumer the greater part of the extra cost incurred in production. At many works it was found necessary or wise to suspend operations. This led again to a smaller total output, while the home and American demand became somewhat more active. The present year is full of potentialities. The first four months have seen great difficulties with tonnage and still further rises in freights. Now, under National Service, Governmental departments are

making further demands from the already depleted number of employees. To meet this demand will mean that of the total number of employees before the war, only one-third or less will remain available for producing China clay. Even the reduced consumption of China clay exceeds greatly such output as can result from these conditions. It cannot be long before all available stocks will be exhausted.—*The Paper-Maker.*

MINERALS IN "GERMAN" WEST AFRICA.

The following particulars of the mineral resources of the former German colonies in West Africa have been reported by the United States Consul at Dakar (Senegal):—

Togoland.—The presence of iron ore, gold, chromite, bauxite, and limestone is reported. The iron ore is of the hematite variety, containing 89·51 per cent. iron oxide, 9·47 per cent. infusorial earth, 0·24 per cent. alumina, 0·16 per cent. manganese oxide, and 0·3 per cent. phosphorous acid. These are mainly found in the Sokode-Basari district. The extent of the deposits probably represents 20,000,000 tons (of 2,240 lb.).

Natural gold is found in the alluvious sediments of the River Moru, auriferous quartz in the vicinity of Atakpame and Sokode, and conglomerates at Kpando.

Chromites, containing a little nickel, are to be found in the south-west of Misahohe, and there exists to the east of Agbandi quartz veins containing pockets of argentiferous lead.

Kamerun.—No important mineral discoveries have yet been made in the Kamerun, but the result of researches effected up to now is encouraging, and justifies a more systematic exploration. There is an abundance of iron ore, especially in the neighbourhood of Bali and Bamenda. The following is an analysis: metallic iron, 42·29 per cent.; manganese, 0·35 per cent.; phosphorus, 0·17 per cent.; and infusorial earth, 12·26 per cent. There are also rich minerals of the magnetic type. Bauxite is fairly extensive, as also is clay; but tin, gold, and wolfram have not been found. Asphalt is to be found at Onidenge and Mamfe; a little coal with 48·3 per cent. of cinder at Mamfe; and salt banks in the district of Ossinge containing from 5 to 8 per cent. of common salt.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Cotton Dealings.—The reopening of the Liverpool market for futures cotton must be read as the failure of the attempt to dispense with a system of trading which unquestionably opens a way to abuse. Cotton, being an extraneous commodity, has first to be imported, and in buying abroad for delivery at home the importer incurs the definite risk of a fall in price. This risk he has been wont to insure by an equivalent sale of imaginary cotton belonging to the month in which the cargo is due to arrive. Upon this basis he has stood to gain as much upon the one transaction as he would lose upon the other, and bankers have not feared to finance bargains which were thus safeguarded. The market facilities in this aspect largely extended the capital of the trade, and their temporary removal, of course, had the contrary effect. Limited to the extent of their own means in meeting the possible losses, importers could not operate nearly as largely as before, and this disability has accentuated the shortness of the stock of cotton. The market has been reopened, not to permit a reign of license in cotton speculation, but simply in order that the trade may get the cotton it needs. At the same time the basis grade has been changed from Middling to Good Middling, with the object of clarifying the position of prices. "Points on"—or, in other words, the premium paid to secure the grade one wants—have become too formidable, and without reckoning them into the calculation, market quotations are misleading as to the actual cost of cotton to the buyer. Cotton will neither be dearer nor cheaper for a change which amounts only to a readjustment of the two parts of one and the same price.

Problems of Education.—Too much else is happening to allow full attention to be given to the problems raised by the Education Bill, and the occurrences do not all assist the adoption of more liberal and courageous views. Manufacturers who are already hampered by shortage of young and of female labour, and who are tugged at for higher wages and shorter hours, are not thereby the more favourably disposed to proposals that would further restrict their labour supply. Abolition of half-time and compulsory attendance at daytime continuation schools would cost the cotton industry, on Mr. J. W. McConnel's computation, about 8 per cent. of the labour in the spinning and weaving branches. The consideration is serious, and it is eminently probable that an arithmetical calculation based upon the ages and hours does not afford an exact measure of the loss of services entailed. More schooling would mean fewer candidates for work in the mill, for the work is not sought by the more highly educated children. The practical result would be that the whole trade would have to be reorganised. Work now done by young persons would have to be given over to older persons, with consequences that are not easy to gauge in the fogged state of the commercial outlook. Employers have no natural disposition to make confusion worse confounded, and they are not unanimously convinced of the advantages to follow from obligatory attendance at continuation schools. It does not seem easy to ensure that classes which must be attended both by the willing and unwilling, the bright and the dull, shall be effective in their main object. Some would willingly go out of their way to get a higher education for individuals selected as especially likely to profit from the pains expended

upon them. Others point out that selection is in itself difficult, and it is the case that disappointing results have attended certain efforts upon these lines, leading their authors round to the opinion that the only education worth having is that which is fought for in the teeth of difficulties. Grit is still more important than knowledge in industrial life, and part-time continuation schooling has been known to interfere with the process of character-building as it is understood in the mill.

The Merchant's Functions.—Due note is taken of the new attitude of the Board of Trade towards the promotion of direct export trading by manufacturers, and its offer of assistance to export combinations, which developments are not too favourably received by merchant exporters of textile goods. The measures are conceived presumably for the benefit of those who have been denied an efficient organisation hitherto, and are the less applicable to textiles, because a highly successful system of trading is in full working order. If the test of the efficacy of a system be the readiness of the majority to make use of it, the credit of the merchant exporters is fully established and upon both hands. The producer gets his orders and his payments with a minimum of difficulty, and the consumer is also delivered from risks. The orders are placed upon the whole with those who can do fullest justice to them, and the goods are properly inspected before shipment. In considering the position of the merchant, reference has to be had to the circumstances of the trade—the number of producers, the fluctuations of value, and the complex character of the goods. On the one hand there are producers with every ability, if they so wished, to sell direct to the foreign markets, and who persistently decline to do it. On the other hand are importers with means of dealing direct with manufacturers who elect to buy from merchants as the alternative to setting up an English house of their own. Both are parties with excellent knowledge of their own business, and they are so numerous that the advantage of merchant dealings can be confidently assumed. The supersession of the export houses has been predicted for as long as most people can remember, but their operations have become larger than ever, and direct selling by manufacturers has been restricted to certain fields. Important work will remain for merchants to do despite any new efforts by combinations of manufacturers or of Government departments.

Hair Belting.—There is no inherent improbability in the reported use in Germany of women's hair to make machine belting. Hair belts are always a possible substitute for leather, and are distinctly preferable under some conditions of running. If, as yet, Englishwomen have not been invited to sacrifice their tresses, the fact may be set down to the adequacy of alternative supplies. Hair for belting fabrics need not necessarily be human, although a percentage of human hair is upon the whole an advantage to the blend. Coarse camel hair and long, strong discoloured wools of all kinds are recognised as eligible, to which may be added discarded queues, shipped from China. A certain eeriness is experienced in face of hundreds of bales of "pigtails," but, after washing and combing, the material can be handled without revulsion. Driving-belts are not the only articles woven from human hair and its mixtures. Heavy wool canvases for other mechanical uses and the cloths used as stiffenings by tailors can be similarly composed.

Fancy Buttons.—Fashionable attention is being bestowed afresh upon buttons as ornaments of dress, and a revival is reported in buttons made with a braiding or embroidery of coloured threads. The production was not always as insignificant a quantity as now. The silk-button business formed the original Macclesfield silk trade, and it spread from thence to other Cheshire and Staffordshire towns. In 1662 the buttons made from Turkey mohair in England were reported better than any brought from abroad, and as production outran consumption Parliament prohibited importation. Means still being found of avoiding the use of silk and hair buttons, it was made illegal in 1705 to cover buttons with such stuffs as clothes were made from. Informations were laid under the Act even as recently as 1778, without, however, producing the effect intended. These worked buttons formed part of the regular stock-in-trade of pedlars, and their modern successors will, no doubt, give home needleworkers a new hobby.

OBITUARY.

John Chalmers Reid.—The death of Mr. John Chalmers Reid took place on August 10th, after a severe operation. He was born at Bonnybridge, Stirlingshire, in 1845. In 1862 he was apprenticed to Messrs. W. Simons & Co., Renfrew, and after holding appointments with various engineering firms he became leading assistant to Messrs. J. & G. Rennie, of Greenwich, where he was responsible for the design and construction of much dredging and marine machinery, and special machinery for extensions of Chatham Dockyard. In 1873 he was appointed Engineer to H.M. Prisons, but he resigned this position in 1887, owing to ill-health. Recovering somewhat from this illness, he devoted himself to the improvement and development of mechanical devices, especially of hydraulic machinery. He also acted as consulting and inspecting engineer to various bodies.

He was elected a member of the Royal Society of Arts in 1881, and for many years he seldom missed a meeting. He was also a member of the Institute of Mechanical Engineers, a manager of a group of London County schools, and a keen worker in educational and municipal matters.

GENERAL NOTES.

MAHOGANY.—Mahogany requires from 100 to 150 years to reach merchantable size. Although it has been planted in India, tropical Africa and elsewhere, it is not considered that the planting of the tree on a commercial scale would be a profitable undertaking. Even in its natural habitat, according to Bulletin No. 474, published by the United States Department of Agriculture, planted trees are often inferior in growth to those resulting from natural seeding. The character of the wood varies according to the country of origin, the marked differences in colour and weight being due to the rate of growth, which in turn depends on soil and climatic conditions. Mahogany, for example, produced on the hard, dry limestone soil of Southern Florida grows very slowly, and is hard, heavy, dark red, and beautifully figured. The mahogany of Cuba and San Domingo grows in a richer, moister soil, and is usually somewhat softer and of lighter weight than that from Florida, whilst the wood produced in those parts of Mexico and British Honduras where the conditions are very favourable to plant growth is considerably lighter in weight, and often much lighter in colour, than that from more elevated regions. Mexico produces larger mahogany trees and a greater yield of timber per acre than any other country; the wood, on the whole, is lighter in colour than that from any other regions, the best produced in the country, as regards size, colour and weight, coming from the interior and higher parts of the State of Tabasco. Honduras wood also often reaches a large size; it has a beautiful dark colour, with a more or less wavy figure. Mahogany from Venezuela and San Salvador is of good quality, being hard, heavy and dark brown in colour. That from British Honduras is straight-grained, often devoid of annual rings, and free from knots. It is moderately soft and light in weight, and in quality and colour compares favourably with wood from Venezuela.

TIMBER IN RUSSIA.—No less than two-fifths of the Empire of Russia is forest land. In European Russia the forests extend over an area of about 345,000,000 acres, of which 214,500,000 acres belong to the State, 88,000,000 to individuals, 26,000,000 to peasants, and 11,000,000 to the Crown, leaving 6,000,000 acres under diverse ownership. In Asiatic Russia, says the *Paper-Maker*, most of the forest land belongs to the State. A conservative estimate puts it at 636,000,000 acres—a low figure, when it is remembered that much of the land is as yet unexplored. Thus vast reaches of the timber belt in the Yakutsk Province, bordering on the Arctic, which have never known the foot of civilised man, are roughly reckoned at 90,000,000 acres. The same is true of the vast forest areas in Eastern Siberia. It is safe to say that two-thirds of the timber land in the Russian Empire lies between the Urals and the Pacific. Of the total 636,000,000 acres owned by the State, 239,500,000 are being worked directly by the Government, with a yield of about 300,000,000 cubic feet of timber.

MINERAL DISCOVERIES IN CANADA.—A message from Calgary, Alberta, to the "Central News" says that practically inexhaustible deposits of manganese dioxide, which is extremely valuable as an iron-toughening material and in great demand for war munition purposes, have been found in the Cypress Hill in South-East Albert. Eight hundred thousand tons, worth approximately £11,000,000, have been blocked out by ordinary post-hole augers in the last few months. The announcement is also made from Canada that the staff of the Department of Mining of the University of Toronto have discovered a process by which low-grade concentrates of molybdenite can be made at little cost. Molybdenite is used for hardening and toughening steel, and it is most useful in the manufacture of high-speed tools. Quebec is a larger producer, but the need for molybdenite is great, and the new process will, it is stated, render available the deposits of low-grade molybdenum ore which have been discovered in Manitoba and British Columbia.

URANIUM STEEL.—The production of ferro-uranium from the uranium oxide obtained as a by-product in the extraction of radium from its ores is, says the *Iron Age*, to be investigated by the United States Bureau of Mines. Ferro-uranium enters into the making of uranium steel, used in Germany for the linings of big guns. Work will soon be begun on the production of sample lots of uranium and other special steels for test by the Bureau of Ordnance for the War Department as to their suitability for use in guns. The work on gun-steel will also require the use of electric furnaces. It has not yet been decided whether this work will be done at Cornell or at one of the other universities which have offered facilities.

JAPANESE GLYCERINE.—The Japanese glycerine industry has developed in a remarkable manner since the outbreak of the war, says the *Chemical Trade Journal*. The Government is now granting pecuniary aid to those engaged in the industry, and the result has been the establishment of the Japanese Glycerine Manufacturing Company and several other concerns. Before the war none of these companies existed, and consumers in Japan relied entirely upon imports from the United States and other countries. The output of the Japanese Glycerine Manufacturing Company alone amounts to 300 tons a month, and in the course of the next few years the imports of this commodity will, it is believed, be nearly stopped.

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PROCEEDINGS OF THE SOCIETY.

HOWARD LECTURES.

THE SHORTAGE OF THE SUPPLY OF NON-PHOSPHORIC IRON ORE.*

By WILLIAM GEORGE FEARNSIDES, M.A., F.G.S., M.Inst.M.E.,
Sorby Professor of Geology, University of Sheffield.

Lecture II.—Delivered May 7th, 1917.

(*Continued from p.* 766.)

Scandinavia.—The iron ores of Sweden and the northern parts of Norway occur among rocks which are accounted by geologists as among the oldest in the world, and in many of the iron districts it is difficult to decide whether the ores should be ranked as plutonic (igneous) or as metamorphic (sedimentary) in origin. The ore bodies consist in general of magnetite and occur in irregular masses or lenticles strung out along divisional planes, which sometimes represent the bedding planes of sediments, in other cases surfaces of flow, injection or foliation among igneous rocks which, under deep-seated conditions, have been involved in the foldings and crumplings of a mountain chain, and have in the process become recrystallised to gneisses and schists.

For the production of the famous "Swedish" iron through many centuries the ores have been selected by hand, and nowadays are either so selected, or, after crushing, the purest magnetite is concentrated by the wet magnetic process. Only the purer parts of comparatively small ore lenticles among the ancient sedimentary series of leptites of Middle Sweden, and especially the numerous ore lenses associated with altered limestones in the forest district some 100 miles to the west, north-west, and north of Stockholm (Norberg, Dannemora, Striberg, Stripa, etc.) are found suitable for the manufacture of Swedish iron. The smelting of the ores is mostly accomplished with local charcoal, to some extent eked out with coal imported from Germany and Britain, and supplemented with electric power from the harnessed waterfalls of the neighbourhood. It is admitted that the supply of non-phosphoric magnetite suitable for the making of high-class Swedish iron is not unlimited, and steps have been taken by the Swedish legislature to prevent its further export in the unmanufactured state. At Grangesberg, Blötberg, and Idkerberg, on the north-west margin of the iron district of Middle Sweden, a series of larger lenticles (up to half a mile in length and 100 yards across) carries a considerable proportion (up to 5·5 per cent.) of apatite, along with mixed specularite and magnetite, and from mines working these lenticles half a million tons of 60 per cent Fe. ore is allowed yearly to be exported.

Of greater importance from the point of view of foreign ironmasters, and containing enormously greater reserves of even richer iron ore, are the immense magnetite lenticles of Norbotten in Swedish Lapland, which are regarded as undoubted magmatic segregations, and occur in association with syenitic rocks. Famous for its magnetite since the end of the seventeenth century, these Lapland orefields waited for development until means of transport were provided from the orefields to the coast, and though an English company was actually the owner of Gellivaara from 1868 until 1889, and English capitalists in the eighties were interested in the construction and finance of the trans-peninsula railway from Lulea on the Baltic to Narvik on the Ofotenfjord, which is a sheltered arm of the Atlantic, it was not until the Swedish and Norwegian States had taken over and completed that railway that development on a considerable

* The course consisted of two lectures, delivered on April 30th and May 7th, 1917. Owing to the restrictions on the size of the *Journal*, it has been found necessary, in rearranging the material for publication, to divide it into three parts.

scale began. Gellivaara became productive in the nineties, but Koskullskulle, which adjoins it, and Kirunavaara with Tuollavaara lying some sixty miles further to the north, did not come into active bearing until the early years of the present century.

Of all these Lapland masses of magnetite, by far the largest is that of Kirunavaara, which, with its northern continuation in Luossavaara, is more than five miles long. Built up of a series of lenticular masses more or less in contact, the average thickness of the ore body over the three-mile-long portion which forms the ridge of Kirunavaara is over eighty yards, and the quantity of ore available under present working conditions is estimated to exceed $1\frac{1}{4}$ million tons per yard of depth, or in total over 700 million tons. The ore is fine-grained, compact, and hard, consisting mainly of magnetite, but with some hæmatite, and averages over 65 per cent. of metallic iron. By selection, cargoes low in phosphorus are obtainable, but in general the ore carries a considerable proportion (over 5 per cent.) of fluor-apatite, and is therefore particularly suitable for the production of iron which is to be made into steel by the basic process.

THE IRON-ORE PRODUCING AREAS OF SCANDINAVIA.

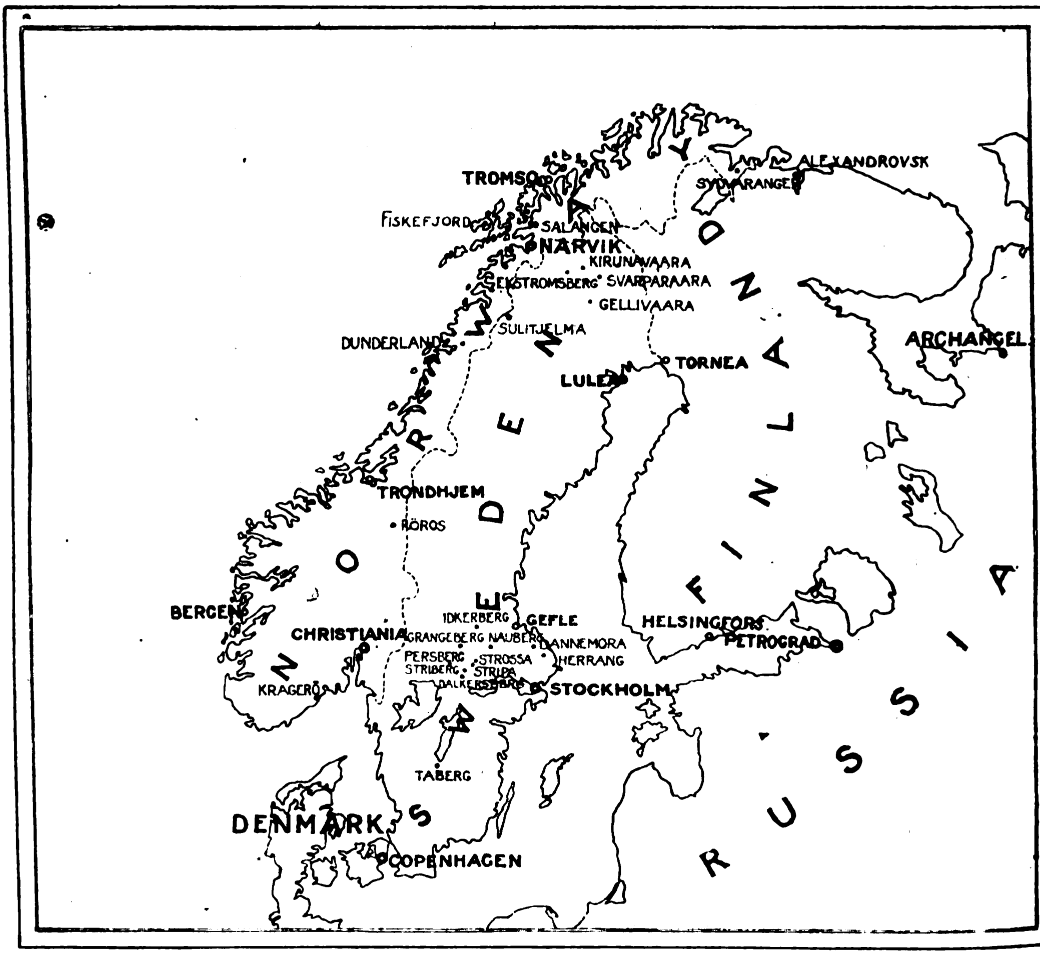


FIG. 5.

Second in importance to the Kirunavaara mass of magnetite is the scattered string of ore bodies which follow a distorted S-like curve from Koskullskulle to Vallkommen, in the neighbourhood of Gellivaara. In this district the gneiss of the side walls and also the magnetite of the ore body is coarser in texture than at

Kiruna. The composition of the ore in the two districts is not dissimilar, but, by reason of its tenderness and granularity, the Gellivaara material does not command so high a price.

There are also several other proved rich magnetite lenticles at Ekstromsberg, Svappavaara, Leveaniemi and Mertainen, all within thirty miles of the Lulea–Narvik railway, but it is not the policy of the Swedish State to have those ironfields developed at present.

Both from the Kirunavaara and the Gellivaara districts, the ore is very dense, and requires a particularly strong coke to carry its burden in the blast-furnace. As, moreover, the great bulk of it when unselected yields a pig-iron which requires the application of the basic process for the removal of its phosphorus, it is not surprising that in recent years over four-fifths of the produce of the quarries (which in the pre-war year exceeded five million tons) has found its market where the making of basic steel is the staple industry in Germany and Belgium.

The conditions which brought about the segregation of magnetite among the ancient gneisses and schists of Sweden into solid ore bodies enormous in their dimensions, seem in Norway to have operated less completely, and though igneous rocks with segregated bands and lenticles of magnetite are abundant among pre-Cambrian granitic rocks at several localities, there is no known Norwegian ironfield where rock can be quarried in quantity and shipped to furnace in the unselected state. Among Norwegian ironfields where development is progressive, the district of Sydvaranger, situate near the shores of the Arctic Ocean quite close to the Russo-Norwegian frontier, is probably the most advanced, and in 1913 exported considerably over half a million tons of 60 per cent. Fe. ore. The rock as quarried is a low-grade material consisting principally of quartz and magnetite, but, by putting the rock through breakers, and selecting the magnetite particles electro-magnetically, a material termed "slich" is prepared which can be briquetted and is saleable as iron ore. The Sydvaranger orefield is from one to three miles wide, and about ten miles long, and it is estimated that there is at least 100 million tons of suitable ore which can be mined by open-cast awaiting treatment. In the Lofoten Islands also, similar large developments of quartz-magnetite rocks, associated with Archæan granites, as at Fiskefjorden and several other places on the island of Hindö, seem to offer opportunities for the development of a similar system of rich iron-ore production.

On the Norwegian mainland, from north of Trondhjem northwards almost up to Tromsö, the belt of Cambrian, Ordovician and Silurian sediments which during the mountain-building process have been converted into schist includes a "banded ironstone" formation, in which the iron mineral is magnetite, mingled with specular hæmatite. At Bogen and Salangen, where magnetite predominates, works for the magnetic concentration of the ore and the manufacture of 65 per cent. Fe. briquettes low in phosphorus have been successfully started. In the Dunderland valley, where over 100 million tons of 35 per cent. Fe. ore might be obtained by open-casting, the iron mineral is mainly specular hæmatite, and the technical difficulties of dealing with it have still to be overcome. As soon as these difficulties shall have been surmounted, it may be predicted that the facilities for sea transport by large boats which can come alongside the concentration plants in the sheltered water of the fjords will enable this district to compete against even the cheaply-worked ores of Kirunavaara, which have to be carried by rail almost 100 miles to ship.

The pyrites ore bodies of Norway occur as clustered lenticles along crush-bands which traverse the metamorphosed Lower Palæozoic sediments of the mountain belt, and as they are always found in association with masses of saussurite gabbro, they are generally regarded as magmatic segregations, belonging to those altered deep-seated basic igneous rocks. Sulitjelma, the Trondhjem district, and the fjords south of Bergen are the principal districts from which the pyrites is exported.

North Africa. — Just as the Bilbao ore belt follows the foothills of the Cantabrian mountains, so in Algeria and Tunis, and probably also in Morocco, the metasomatic hæmatites of North Africa follow the foothills of the Atlas Range (*cf.* Fig. 3). First worked at Beni Saf, quite close to the coast at Oran, as long ago as 1870, non-phosphoric replacements of saccharoidal limestone have been discovered at intervals along the line of outcrop of the unconformity where ancient schists and gneisses are overlain by Mezozoic (Lias or later) sediments as far eastwards as Tunis, and many of them have been brought into bearing as soon as railways have been built to carry the ore to ship. The most prolific of the quarries is still that at Beni Saf, where, however, the ore body promises to become exhausted if worked at the pre-war rate for another half-dozen years. Many other

Algerian ore bodies, *e.g.*, at Rar el Maden and Kristell in Oran—Zaccar, Rouina, Breira and Temoalga in Algiers—and Beni Falki, Temezrit and Mokta in Constantine, are ready to provide increased supplies of similarly high-class non-phosphoric ore, and there is no reason to expect that the hæmatite production in France's greatest North African dependency will in the future do other than increase.

In addition to the richly-productive formation at the base of the Liassic series, there is also a higher horizon among the sediments of the Cretaceous formation, at which ores of the hæmatitic class are abundant. Cretaceous ironstones are already worked at Ténès, halfway between Algiers and Oran; and on the flanks of Djebel Ouenza and at Bua Kadra on the borders of Tunis, a very large mass—possibly a true bed of ore—overlain by grey limestones, belongs to the Lower Cretaceous (Urgonian), and resting upon the gypseous marls of the Trias, has been prepared for working, and its active development only awaits the linking up of the railway to Bône.

In Tunis the iron-ore industry was only started in 1907, but has since grown rapidly. The ore bodies mostly follow the unconformity which there separates Cretaceous from Triassic rocks. The ores worked at Djebel Djerissa and Djebel Slata are regarded as portions of the great L'Ouenza and Bua Kadra sheet, proved but not yet worked on the Algerian side of the border. Ores from these deposits, though classed as hæmatites, are often manganiferous and in places somewhat phosphoric, so that only a portion of the unselected material is suitable for the making of acid steel. Of the 125 million tons of ore reserves accounted by the International Congress as proved in French North Africa, over half is in the district about L'Ouenza and Djebel Djerissa.

In 1913 the Algerian output of iron ore was a little more than one million tons, and the tonnage produced in Tunis considerably exceeded half that quantity. From Algeria the Atlas Mountains continue unbroken in a south-westerly direction, but, in the absence of railways, the large hæmatite masses noted by travellers as occurring among the foothills of those mountains in Morocco have not yet arrived at the stage for commercial exploitation.

North America. — In the years before the war, produce from the orefields of North America affected the British market rather as a commercial competitor in outside markets than as an alternative supply; and only in the case of the Wabana mines, situated on the seaboard of Newfoundland, has any serious attempt been made to bring raw ore to British furnaces from the western side of the Atlantic. For smelted metal, however, the case was different, and for many years American steelworks have found in Britain a market for certain semi-manufactured as well as manufactured goods. Moreover, since the outbreak of war, the British metal market, which in former times was stocked with the produce of the Lorraine orefields, has had to replace that stock with supplies bought in from America; there is, therefore, good reason to include under the title of this lecture some brief account of the major ironfields of America.

The Lake Superior Region. — At several horizons in the midst of the Huronian, Laurentian and Keewatin groups of the Algonkian and Archæan sediments which form the ground rock in the region of the Great Lakes, there occur in the States of Minnesota, Michigan and Wisconsin, west and south of Lake Superior, numerous "banded jasper and ironstone formations" which are very rich in specular iron ore. Along certain belts of tectonic folding, known as "ranges," profound alteration and segregation of the iron minerals has taken place; and along surfaces where pervious and impervious strata join, ore bodies, irregular in shape but often very pure and of enormous dimensions, have segregated. From south-east to north-west the order of the principal ranges is: Menominee, Marquette, Gogebic, Mesabi and Vermillion—of which Menominee crosses the State boundary between Michigan and Wisconsin, while Vermillion, partly in Minnesota and partly in Ontario, lies athwart the international boundary between the United States and Canada. Largest of all the ore bodies are those of the Mesabi range, which, in the five years 1908–12, was responsible for 66·5 per cent. of the total production, mostly from open quarries. In Menominee, which stands next with 10·7 per cent., Marquette 9·8 per cent., Gogebic 9·5 per cent., and other ranges with the 3·5 per cent. required to make up the total, "shaft-mining" is the rule.

There being no coalfield nearer than that of Pennsylvania, which is distant some 800 miles, about four-fifths of the ore from the Lake Superior region is shipped, much of it through the port of Duluth, through Lake Huron and the canals to ports on Lake Erie, and sent thence by rail to the Pittsburg district, while the remainder goes to Chicago there to be smelted with coke brought by train from the Connelsville

district of Pennsylvania, or with coal from the Kentucky coalfield.

For magnitude of present output, which is about 80 per cent. of the total American production, as also for the gross quantity of the metal yielded in the past, the Lake Superior region of America maintains its precedence over all the ironfields of the world. In recent years there has been won from it over one-third of the whole world's iron output, and since it was first opened up in the majority of the recent great extensions of their works. The available reserves of ore in the Lake Superior region are enormous, especially in Mesabi, and have been variously estimated at between 2,000 and 3,500 million tons, with a further 70,000 million tons of lower-grade material also there in view.

The Appalachian Region.—Outside the Lake Superior region, the most important iron formation in America is the Clinton oolitic

FIG. 6.—AMERICAN IRONFIELDS.
Lent by Messrs. Macmillan & Co., Limited.

about 1850, the weight of pig-iron produced must have exceeded 400 million tons, of which production considerably more than half belongs to the twentieth century. Most of the ore won is classed as hæmatite, but except in the Gogebic and Vermillion ranges "the best of the high-grade Bessemer ore is reported to be exhausted," and in consequence the steel-makers of America, making a virtue of necessity, without reducing appreciably their output of acid (Bessemer) steel, have adopted basic open-hearth furnaces

ironstone, which belongs to the Silurian system, and is developed along the flanks of the Appalachian Chain. This sedimentary series has many features in common with the Minette series of Lorraine, and like the Grey Bed of that series does not deteriorate in quality for smelting when mined in depth. It is worked most extensively in the Birmingham district of Alabama, and in the adjoining districts of Northern Georgia and part of Southern Tennessee, where it lies conveniently close to the Kentucky

coalfield; but it is also productive in Pennsylvania and in New York State. The present output (over 10 per cent. of the total production of the United States) is about equal to that of Cleveland. The available ore reserves exceed 500 million tons.

The Adirondack Region.—The magnetite-hæmatite ore bodies among the crystalline rocks of New York, New Jersey, and Pennsylvania are of a type like the similar ores of Sweden, but the individual lenticles do not attain such large dimensions.

Cuba.—The 55 per cent. Fe. brown hæmatites which are imported to the United States from Eastern Cuba are surface deposits derived by tropical weathering from serpentine and other very basic igneous rocks. They contain an appreciable percentage both of Chromium and of Nickel, and are smelted directly for the production of alloy steel. A vast reserve, estimated at 1,900 million tons, of similarly rich ore has been surveyed in Cuba.

British North America.—The ironfields of the great Dominion are as yet imperfectly prospected, though there is information that many of the Lake Superior ranges are continued on the Ontario shores of the lake. From some of these and from the north-eastward continuation of the Clinton ore belt, ore is provided for furnaces sited near the coalfields of Nova Scotia and New Brunswick, to which district also are brought the ores from the Wabana mines in Newfoundland. The Wabana mines are situated on Great Bell Island in Conception Bay, within a score of miles of St. John's. The ore, which is a somewhat phosphoric 50 per cent. Fe. hæmatite, occurs in several beds, of which two, respectively 8 ft. and 10 ft. thick, occurring interbedded with Upper Cambrian sediments, are mined partly on the island, but mostly beneath the waters of the straits which separate that island from the mainland. The output from these mines exceeds a million tons a year, but the project of sending ore from them to furnaces in Britain has not yet proved an economic success. The proved ore reserves are enormous: in 1910 they were estimated at 100 million tons on the island, and 3,522 million tons beneath the waters of Conception Bay.

Western France.—Despite their nearness to the ports of Britain, and notwithstanding that the districts where they occur purchase from British coalfields more than seven-eighths of the considerable quantity of coal which they import, the orefields of Western France have received but scant attention from the ironmasters of this country, and over two-thirds of the iron ore which they have exported in the past has been sent to Germany. The district in which the ore beds are developed lies to the north of the River Loire, west of a line joining Le Havre to Bordeaux (see Fig. 3). The ironstone formation is the *Calymene* bed or group of beds, which belong to the Upper Arenig (Llanvirnian) series of the Ordovician system, and occur in N.W.–S.E. ranging synclines, sharply infolded among older phyllites and eruptive rocks on the flanks of the Armorican massive. Within the Normandy or northern district, which is served by the ports of Caen, Rouen and St. Malo, four parallel synclines—(1) May and St. André, close to Caen; (2) Barberry and Soumont, between Caen and Falaise; (3) St. Remy; and (4) La Ferrier, north east of Domfront—have been brought into bearing, and in steep measures mining development is proceeding on an ever-increasing scale. At the surface, and sometimes for a depth of from 40 to 100 yards below it, the ore bed, locally converted into a 50 per cent. Fe. limonite or hæmatite, is ready for smelting as delivered from the mines. In general, however, as mined the rock bed is a very compact oolitic ironstone, consisting essentially of iron carbonate or siderite, and requires calcining before it is sent to furnace. By boring at Soumont the ironstone bed has been proved 14 ft. thick and workable at a depth of over 450 yards, and it is expected to continue workable down to 1,000 yards. If this estimate is trustworthy, it must follow that in the Normandy district there is an ore reserve of over 200 million tons, all within sixty miles of Caen.

In the more southerly region of Anjou and Brittany there is as yet no very systematic mining, and only in the Angers-Segré district, where skimming of the weathered ore from the outcrop is in progress, has any development of the *Calymene* bed *in situ* begun. At Rougé, to the north of Chateaubriant, as at many places on the low ground between St. Malo and Nantes and about the mouth of the Loire, the ore worked is mostly rubble occurring in thick masses washed down and reassembled from undiscovered outcrops of ironstone in the hills. In such a district there is great hope of discoveries of ores richer and possibly less siliceous than those already worked. The output from the Anjou and Brittany district in 1913 was just less than half a million tons. In 1916 the output of mines in Normandy, where the rate

of production is now expanding rapidly, exceeded one million tons. When used for steel-making, the pig-iron made from the Ordovician ores of Western France requires to be refined by the basic process.

Other Foreign Countries.—From the islands of the Ægean, and from the coasts of the mainland adjoining them, there has in past years been exported to this country a considerable, though decreasing, quantity of high-class hæmatite, and in recent years some special hæmatites containing appreciable percentages of chromium and nickel or manganese have also been sent. The ore bodies worked appear to be metasomatic replacements of Cretaceous *Hippurites* Limestone, related in some way to a group of well-defined faults and to an older rock series which includes decomposed serpentinous rocks, against which the Cretaceous limestones rest unconformably.

As from Greece, so also from Southern Russia, the import of iron ore had during the pre-war decade decreased considerably, but for another reason. The accessible ore bodies on the Grecian islands (*e.g.* Seriphos) were becoming exhausted, and facilities for transport from ore bodies inland were not sufficiently cheap. In South Russia, on the other hand, the great coalfield of the Donetz basin has become a fuel-producing area on an extensive scale, and the rich produce of the Krivói Rog ironfield, from which the ore was formerly exported, is required for furnaces at home. The Krivói Rog ore mass, situate about 150 miles N.E. of Odessa, is a Pre-Cambrian complex of quartzites and jaspers with other siliceous schists, which include numerous lenticles of mixed magnetite and hæmatite. Many of the individual ore lenses are large and of unusual purity, and it is estimated that considerably over 50 million tons of non-phosphoric ore, containing an average of 62 per cent. of iron, has been opened out ready for quarrying.

The hæmatite supply from Italy is also failing rapidly, for the iron mines of Elba are exhausted, and such cargoes as are now exported are obtained by crushing and hand-picking of material which in former times was sent over the tips.

The ore noted as imported from Chile is hæmatite brought back as ballast by vessels which on the outward route carried coal.

British Possessions.—In closing this account of the overseas ironfields which send supplies to the British market, some mention must be made of the mineral resources of British territories overseas. The ironfields of the overseas Empire, like the great ironfields of America described above, are separated from home furnaces by distances too vast for it to be economical to bring so low-priced and bulky a commodity as iron ore to compete with the produce from ironfields in European countries which have no coal. Fortunately there is coal in Canada, in Australia, in South Africa, in New Zealand, and in India, and also in several of the Crown Colonies situate in the tropical belt, and when the time arrives when iron can be smelted in these countries at a cost cheaper than it can be bought in from Europe, we may expect to see local iron industries develop perhaps to such an extent that outlying portions of the Empire may send manufactured or semi-manufactured metal to supply the British market.

The case of Eastern Canada has been commented upon already. It may be added that there are rich ironfields and coalfields situate in close proximity both in the North-West Provinces and along the British Columbian coast, which are likely soon to arrive at the stage of active steel production. In the Australian Commonwealth great blast-furnaces and steel works have been set up in the Newcastle (New South Wales) coalfield to smelt rich hæmatites sea-borne from Iron Knob and Iron Monarch, hills on the Eyre Peninsula, on the western side of the Spencer Gulf, in South Australia. British India is not behindhand, and ores from the Dharwar series of Pre-Cambrian rocks of the Central Provinces are being smelted in the coalfield of Western Bengal. Produce from each of these regions has been made available in Britain for the prosecution of the war.

The Commonwealth of South Africa and the Dominion of New Zealand have as yet no iron-smelting industries, but in each of them, as also in the Crown Colonies of West Africa, Central Africa, and North Borneo, it is known that there are vast reserves of iron ore not too far distant from the coal.

CONCLUSIONS.

Ore Values and Transportation Costs.

Reviewing the conditions of ore supply from overseas ironfields to British furnaces, we note that in them—as in the home ironfields—there is already a shortage of readily accessible non-phosphoric hæmatite, and that it is only in the more distant countries, where railways are being

built to link up ore bodies with the ports, that there is any prospect of a considerable increase in the supply of pure hæmatite. A glance at the graphs (Fig. 7), which represent the iron-ore output from the principal iron-producing countries of the world, confirms this inference, and reminds us that, at any rate since the beginning of the present century, the only countries which have made notable progress in steel production have increased their output by

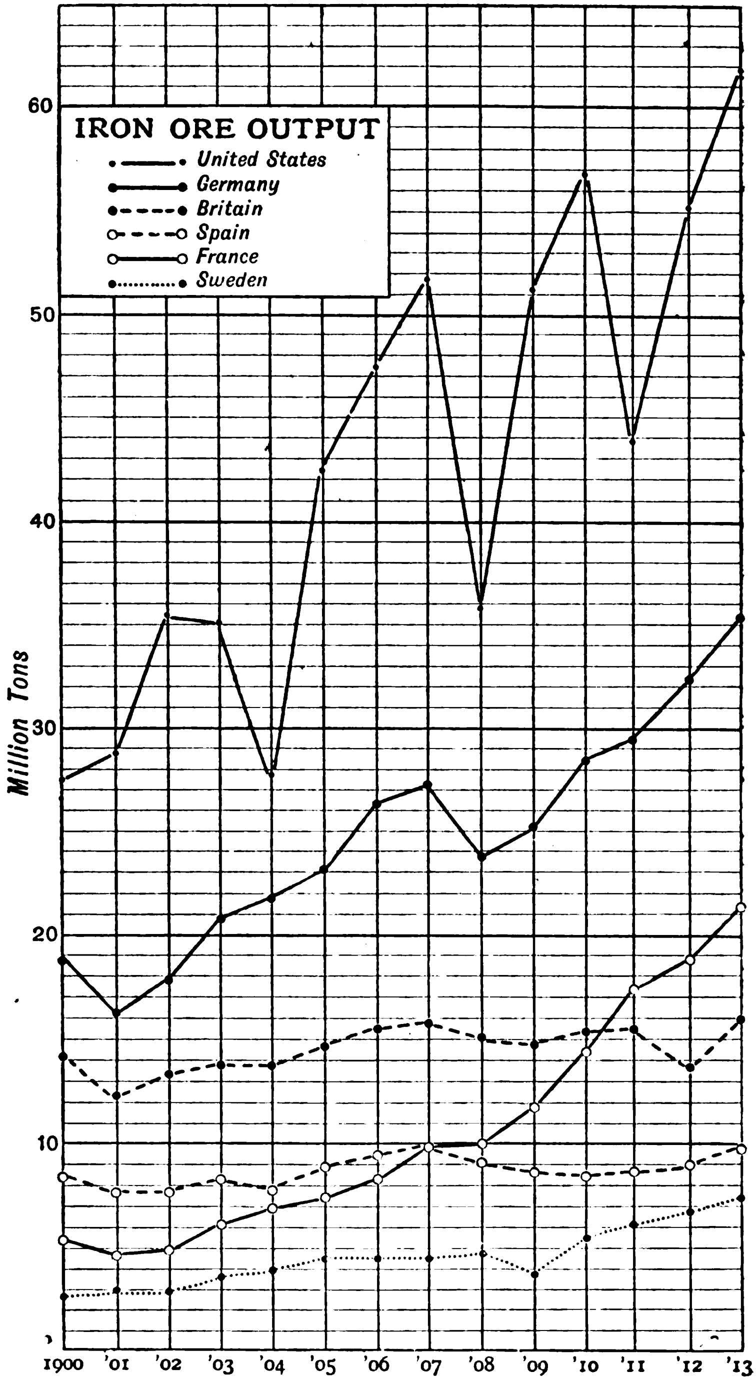


Fig. 7.—Curve of Iron Ore Output of United States and Europe.

developing supplies of phosphoric ores, of which there is an ample, if not an inexhaustible, reserve.

Since, nowadays, before it reaches the engineer-consumer, the produce of blast furnaces is mostly converted into steel, it may not be out of place here to enter a plea for the more general adoption of some process of steel-making which will allow the use of these ores which are more abundant and more cheaply accessible to British blast furnaces than are the failing supplies of hæmatite.

For the production of acid steel, the chief natural advantages which have enabled this country to outbid all foreign rivals in the over-seas markets whence hæmatite ores are brought are the native wealth and extensive development of the home supply of fuel, and the accident of geography which sited our magnificent coal-fields near the harbours of our coasts. Abundance and accessibility of coal supply enabled this country early to develop the wrought-iron industry which depended for its supplies upon the Coal Measure ores. Abundance, cheapness, and the high quality of the fuel available as bunker coal and for export, have enabled this country to maintain the supremacy of its mercantile marine throughout the age of steam; and notwithstanding that the change from iron to steel brought with it the closing down of more than half the home Coal Measure ironfields and the replacement of their produce by more expensive ores brought in from Spain, British ironmasters were able to accept and profit by the changes in engineering constructional practice thereby entailed. Mercantile marine supremacy and a surplus coal production available for export carried with them the economic control of the markets for all bulky materials at the coalless ports of countries around the Mediterranean Sea, and when a shortage of supply seemed to be developing at the hither ports, other and more distant sources of supply were brought into bearing to meet the market's needs. Mercantile marine supremacy has been the dominant factor in securing to our ironmasters their ample hæmatite supplies, and as the shortage of hæmatite convenient to the northern ports of Spain has been increasing, British ironmasters —able to charter adequate shipping tonnage to bring supplies from Southern Spain or from North Africa—have been the last to feel the pinch. Quality, when attainable and necessary, will always bear the cost of transport, and where high quality has been asked for ironmasters have been able to hand on to the consumer the additional price of freightage which the longer voyage entails.

Basic v. Acid Steel.

At the commencement of the age of steel production in the eighties, and on into the nineties, the advantage of quality possessed by steel made from Spanish or Mediterranean hæmatites in British plants, which were then new and up to date, was very great, and during the first twenty years of the steel era this country led the world. Thereafter, with the perfecting of the "basic" process, the Germans, whose coalfields are not close to seaboard, and whose ironmasters had been held off by competition with the British from obtaining what they regarded as an adequate supply of hæmatite, were able to put on the market at very low prices, as a substitute for the lower grades of acid steel, steel made from the Minette ores of Lorraine, or from phosphoric magnetite which they had bought in from Sweden; and by the end of the nineteenth century British supremacy, measured in terms of tonnage of steel output, had been lost. Quality, where it is not essential, is a luxury not worth paying for, and since the quantity of acid steel which can be made in Britain depends upon the amount of shipping tonnage available for the cheap carriage of hæmatite from distant ports, it is not surprising that the rate of expansion of the acid-steel industry has not been so great as the rate of development of the younger basic-steel industry of Germany, which draws its ore supplies from more extensive and regular deposits situate in closer proximity to the coalfields; or that, for constructional engineering purposes, supplies of acid steel which are good but—by reason of freight charges on the ore—expensive have been largely supplanted in the markets of the world by supplies of basic steel, which is sufficiently satisfactory and also cheap.

In Britain, so long as an abundant supply of rich hæmatite ores from overseas remained available, there was little commercial advantage to be gained by smelting the home supplies of low-grade ores, and British ironmasters, being in possession of expensive plant specially suited to the production of hæmatite iron, have been somewhat reluctant either to reorganise or to extend their works for dealing with the cheaper or lower-grade phosphoric ores. In consequence, during the present century, though the tonnage of steel produced in this country has shown continuous increase, and healthy young

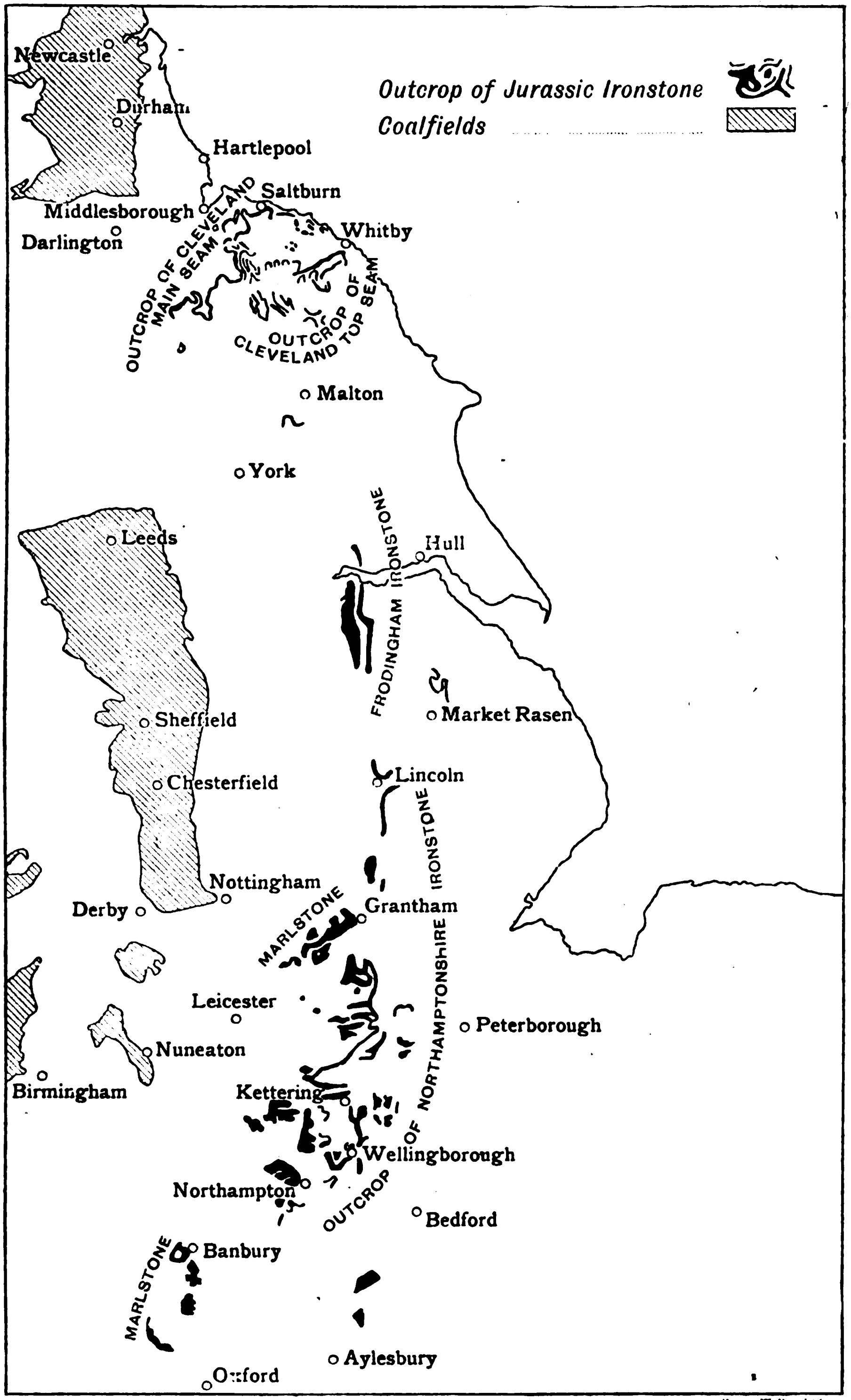
steel industries have sprung up in Canada, Australia and India, the place of the British Empire as a producer of steel has not been maintained, and only for high-quality tool and special alloy steels has she continued to supply her former proportion of the world's demands.

By taking the fullest advantage of those neighbouring ironfields from which she could obtain the cheapest ore, Germany advanced her output from a production hardly more than that of Britain at the beginning of the century, until at the outbreak of war it was equal to the sum of all the outputs of France, Britain, Russia, Italy and Japan, in fact of all the nations —save only America—which have since been compelled to ally themselves in arms against her. In face of economic difficulties determined by the geographical distribution of her mineral supply, Germany certainly made the best of what she had at hand. Having adopted the policy of cheapness she carried it to its logical scientific conclusion, and when, during the first days of the war, the German armies succeeded in advancing beyond the western margin of the Minette orefields of Lorraine, the German commercial policy, always planned to meet the expectations of her war lords, was consummated, and the source of raw materials from which her supply of steel for war purposes is largely manufactured was, as she believed, secured.

In America, where the whole resources of a continent are at the disposal of the steel industry, reserves of hæmatite, especially in the region of Lake Superior, are more abundant than anywhere else known. Nevertheless, in America, as in Germany, it has been recognised that it is cheaper to work up those ores which are abundant and occur in large masses conveniently situated in relation to existing transport lines—leaving it to the steel maker to burn out the deleterious impurities—than to seek out or select from scattered ore bodies hæmatites which are sufficiently non-phosphoric to yield iron suitable for steel-making on the acid open-hearth. In America, therefore, although the production of acid steel in Bessemer converters is not yet waning, most of the new extensions of the industry made during the last ten years have adopted the basic open-hearth process of steel-making, and most of the vast increase of pig-iron production in America during the last decade has been from ores which do not belong to the non-phosphoric class.

It was shortage of hæmatite which compelled Germany to take up overseas supplies of those ores which are not wanted by the British makers of acid steel. It was recognition of the availability of large ore bodies, conveniently situated for the sending to furnace of ore which could be cheaply won, but was not quite suitable for steel-making by the acid process, which persuaded the American ironmasters likewise to make the change. Shortage of Spanish and Mediterranean hæmatite has been with the German ironmasters from the beginning, and will gradually overtake the ironmasters of this country. As it has paid America to adopt the basic process in its modern works extensions, so it should be profitable to this country to develop its steel-making practice in a similar direction. Already, and especially since the outbreak of war, the production of basic iron on a large scale has made progress, and an effort has been made to produce from home Jurassic ores iron to take the place of the two million tons and more of semi-manufactured basic metal which was formerly imported year by year from Germany or from Belgium; but, whereas in Germany only one-sixth, and in America about one-third, of the total steel output is classed as "acid," in this country in the pre-war year the pig-iron production returned as "hæmatite" was nearly four times as great as the output from furnaces which were making "basic" pig-iron.

In the most recent year (1916), during which a British record for steel production has been established, the basic-steel output shows proportional increase, but the production of hæmatite pig-iron is responsible for over two-thirds of the total increase of pig-iron output on the previous year. In war-time the call for high-class steel of reliable quality is especially urgent, and so long as rich hæmatite ore can be bought there is considerable saving of home labour both at the mines and at the furnaces. In peace-time, as it appears to the author of these lectures, hardly more than one-fifth of the total British pig-iron output is needed for purposes which suitably refined basic iron could not be made to serve. Prior to the war, when shipping tonnage was abundant, almost exactly one-half of the British pig-iron was made from foreign ore. Does it not seem that, when labour again becomes available for mining or quarrying home ores, and for handling the greater bulk of lower-grade material at the furnaces, it will be sound policy for this country to adopt the basic process on such a scale that even with expanding trade it will become unnecessary to purchase from foreign countries so large a quantity of ore, for the carriage of



Emery Walker Ltd. sc.

which so great a proportion of our mercantile shipping tonnage has in the past been employed ?

The Future of the British Blast-furnace Industry.

If for bulk production the change over from "hæmatite" to "basic" steel be effected—and should the recent rate of loss of shipping by enemy action long continue, a change in this direction must undoubtedly be faced—the onset of the change must affect the blast-furnace industry in different districts of the country very unequally. Blast furnaces are generally located near the margin of the coal-fields, and on the sides of the coalfields which are nearest to the iron-ore supply. To British coalfields adjoining the western coasts of England and Wales and of Scotland, ore from the northern ports of Spain has in the past come by sea more cheaply than an equivalent amount of ironstone could be supplied by rail from the Jurassic ironfields of the eastern counties of England. Orefields in Northern and Western France, where the ore is "basic," are nearer to these western British coalfields than are the Spanish ports, but unless the shorter sea passage and facilities for quick loading outweigh the disadvantage of lower metal content of French as compared with Spanish ore, the available shipping tonnage will probably continue to be employed to greater economic advantage in carrying the richer ores from Spain, and perhaps also the hæmatite from the Mediterranean coasts. The blast furnaces near the western coalfields are therefore likely to continue to manufacture hæmatite iron from Spanish and Mediterranean ores.

To coalfields on the eastern flanks of the Pennines, more especially the coalfield of Northumberland and Durham adjoining the North-East coast, ores from the ironfields of Scandinavia and also those of Northern France have a considerably shorter sea passage than from Spain, and in these districts it would seem that by economic conditions the smelting of basic iron from phosphoric ores will be encouraged to increase. Adjoining this North-East Coalfield, there is the rich Jurassic ironfield of Cleveland; and further to the south, not far from the South-East Pennine (North Midland) Coalfield of Yorkshire, Derbyshire, and Nottinghamshire are the wide orefields of Lincolnshire, Leicestershire, Northamptonshire, and Oxfordshire, conveniently situated in proximity to this greatest of British home reserves of coal. It was in the Cleveland district that the basic process of steel-making had its first beginnings. Now both in Cleveland and in the East Midlands further to the south, the basic-iron industry has taken root and is growing rapidly; and, with the experience of the past to guide it, and unhampered by great distances, such as those which separate Lake Superior from the Pennsylvanian Coalfield or Lorraine from the Westphalian supply of coke, between the ironfields and the coal supplies, there is great opportunity for development, which, in the course of a few years, might raise the British basic-steel output, if not to surpass the production of North America, at any rate to equal the pre-war production of Belgium or perhaps that of the basin of the Saar.

With five thousand million tons of ore ready for quarrying or mining within fifty miles of a region which holds at least fifty thousand million tons of the very best non-anthracitic coal, there is no valid reason for the iron and steel industries of Eastern England to look forward except in confidence to the time when the price of overseas hæmatite becomes prohibitive. Let us use foreign hæmatite for acid-steel production as long as it pays to use it, in the certainty that when the accessible supplies of it become exhausted a vast quantity of home Jurassic ore will remain. Let us not be beaten in the steel markets of the world because we insist on supplying only steels which have been made from hæmatite, but, taking advantage of the perfected basic process, let us apply a more considerable proportion of the country's abundant fuel-wealth to the making of that class of steel which can be manufactured cheaply from the ironstones of the English Jurassic or from other of the abundant, widely distributed and accessible phosphoric ores.

Postscript.

In conclusion, I wish to return thanks to various friends for help received during the preparation of these lectures for publication. The maps have been drawn under my direction by my friend and pupil, Mr. H. F. Atkinson. The graphs, Figs. 1 and 7, were prepared by my colleague, Mr. T. S. Ashton, Lecturer in Economics at the University of Sheffield, who has also rechecked the figures quoted in the tables. For permission to reprint the graph Fig. 2 acknowledgments are due to the Chief Inspector of Mines and to the Comptroller of H.M. Stationery Office. The blocks, Figs. 3, 4 and 5, have been kindly lent by the Society of Engineers—they are reprinted from a former paper of my

own. Fig. 6 is borrowed from Mr. S. J. Truscott's translation of "Ore Deposits," by Beyschlag, Vogt and Krusch. My thanks are due to Messrs. Macmillan for permission to reproduce the block. I also offer grateful thanks to my wife, who has done much to make the MS. ready for publication, and has greatly lightened my labours by undertaking the correction of the proofs. W. G. F.

Sheffield, June 25th, 1917.

ENGINEERING NOTES.

A Novel Heavy Electric Locomotive.—A 240-ton electric locomotive, with a tractive capacity at maximum speed of 87,200 lb., has been built by the Pennsylvania Railroad for trial service on the company's electrified lines at Philadelphia, and possibly on the Norfolk and Western mountain electrified section. The locomotive is designed to handle 3,350 tons on a 1 in 100 grade. Two of the engines, one pushing and one pulling, will be able to haul a 3,900-ton train at 20·6 miles per hour up the 12-mile 1 in 50 grade from Altoona to Gallitzin, or a 6,300-ton train up the 25-mile 1 in 100 grade from Johnstown to Gallitzin. A novel feature of the new locomotive is the placing of the motors ahead of the drivers, adjacent to the pony trucks. There are four motors, each with a rating of 1,200 h.p. Two motors are mounted on each unit. The units are articulated, but there is only one car-body for the two units. As in the Norfolk and Western electrification, energy is derived from an 11,000 volt, single-phase 25-cycle overhead system in conjunction with a phase converter. Only one normal operating speed, 20·6 miles per hour, is provided. This speed is the maximum that is considered safe for the heavy trains that the locomotives will be required to handle on the grades of the Altoona division. A speed of 10·5 miles per hour can be obtained by connecting the motors in "cascade." The locomotive is 76 ft. 6¼ in. long over all. Some of the above particulars are furnished by the *Engineering News Record.*

Water for Panama Canal Lockages.—From a study made of the water supply for the Panama Canal it was ascertained that an average of 7·21 million cubic feet of water was used for each through lockage from ocean to ocean; that an average of 12,787·47 million cubic feet of water was wasted over Gatun spillway, or a sufficient quantity of water to make 1,773 through lockages each month. Based on a 30-day operation, this would mean 59 lockages per day over and above the average traffic for the past year. According to the latest annual report of the governor of the Panama Canal, the maximum number of lockages which can be made in 24 hours is 48, assuming that one vessel leaves the upper flight at Gatun just as another enters the lowest chamber, and *vice versâ*, both chambers being used.

Nitrogen from the Air: a New Zealand Project.—The National Efficiency Board, New Zealand Government, has invited Mr. J. Orchiston, Chief Electrical Engineer to the Post and Telegraph Department, to report on his proposal for establishing an industry in New Zealand for producing nitrates from the air. Mr. Orchiston has acquired data dealing with the cost of hydro-electric schemes in Germany, Norway, and Italy; and in no case, he said, can electricity be generated as cheaply as by utilising any of the large falls in the south-western sounds of New Zealand. One of the simplest propositions is that presented in utilising the Bowen Falls, in the Milford Sound. He estimates that, after making full allowances for all contingencies, energy could be produced for one-fiftieth part of a penny per unit, or one h.p., at a cost of £1 per annum. For nitrogen fixing from the air, Mr. Orchiston doubts if there is a more favoured spot in the world, for at the Bowen Falls there is deep water close to the side of the sound, and perfect shelter in all kinds of weather.

Concrete Ships.—These ships have been made in Norway and in the United States and elsewhere. Of the soundness of the system therefore there can be no longer any doubt. British naval architects, says the *Daily Telegraph*, have already prepared designs for such ships of a standard pattern for which they are ready to quote firm prices and to guarantee results. Costs will be found to be distinctly lower for ships made of reinforced concrete than for vessels of similar capacity built of steel. We have the authority of a valued correspondent for the statement that the cost of ships constructed of reinforced concrete may safely be put at one-third of that for steel vessels. Nor do the advantages of concrete ships end here. There is the additional advantage—one of the most important of all in these days when the need for quickly replacing the tonnage sunk by German submarines is so clamant—that concrete ships can be constructed far more rapidly than can those of steel, requiring for their construction less labour, and labour of a lower degree of skill, than that needed for ordinary shipbuilding.

Indian Wheat Elevators.—Mr. G. Valder, Indian Government, Under-Secretary and Director of Agriculture, recently called for tenders from Australian contractors at a price per bushel for the complete erection and installation, including all machinery, of a bulk-handling system of wheat for the State of New South Wales. The scheme as designed by the John S. Metcalfe Co., Ltd., engineers, who have reported on similar schemes for the State Governments of Victoria, South Australia, and Western Australia, provides for terminal elevators at Sydney and Newcastle (N.S.W.), with respective capacities of 3,000,000 and 800,000 bushels, and country elevators at

selected localities having a total capacity of not less than 12,000,000 bushels. The Sydney elevator is to be erected on a site at Glebe Island, and that at Newcastle at Wickham Basin. The country elevators are designed with capacities of from 50,000 to 200,000 bushels. The cost of the scheme is £2,000,000. Whatever may be the case in India, where tentative experiments in elevators for wheat are now being made in the Punjab, it would appear that the system should be effective for the conditions prevailing in Australia. Anybody who has seen the conditions of the wheat trade at Sydney for instance, as recently as ten years ago, with hundreds of thousands of bags of wheat lying in the open at and around Pyrmont, will be ready to believe that a good case exists for the elevator system.

Irrigation in Siam.—Extensive projects for the introduction into Siam of systematic irrigation after the best modern methods have been on foot for the past few years, and a beginning seems already to have been made with their execution. The *Geographical Journal* says the need of taking the matter in hand was recently emphasised by a bad rice harvest. The result was the loan, by the Government of India, of the services of Mr. T. R. Ward, C.I.E., an officer of wide experience in irrigation, both in South Africa and in India. After a full study of the material already collected and a detailed survey of the ground, Mr. Ward formulated proposals for work to be put in hand at once, both in the plains of the Menam and in the basins of two other Siamese rivers. He points out that these streams form, in the lower Siamese plain, alluvial fans which lend themselves readily to irrigation so far as they remain above high-level. The Menam itself sends off three deltaic arms or distributories, which have in turn built up subsidiary fan-cones which can be irrigated by using the distributory as a main canal, developed and improved by suitable works. For perennial irrigation a barrage on the Menam above its delta would be necessary, but the time is not yet ripe for a project of such magnitude, and Mr. Ward advised taking in hand at the outset the improvement of one channel only—the Subharn—resting content with high-water irrigation at the time of the rice crop. The area to be so benefited has hitherto been poorly developed, and the construction of an irrigation network here would be a first-rate object-lesson to the cultivators. He also advised the immediate adoption of projects for the partial utilisation of the Prasak and Bhejaburi rivers, as also for a limited extent of irrigation in the hill districts of the Upper Menam at Lampang, and for drainage and other works in the flat plain below Ayuthia. The total cost of these projects would be about one and three-quarter million sterling, but a complete system of irrigation such as might be looked forward to for the future might entail an outlay of ten millions.

OBITUARY.

Clayton Beadle.—Information has been received of the death of Mr. Clayton Beadle, which took place at his residence at Sidcup, Kent, on August 16th, at the age of forty-nine. After being educated at Dover College, he entered the St. Mary Cray Paper Mills of Messrs. William Joynson and Son, ultimately becoming consulting chemist to the firm. In 1886 he was associated with Messrs. C. F. Cross and E. J. Bevan in reporting on the fibres at the Indian and Colonial Exhibition; in 1889 he made a tour round the world in order to collect information respecting the raw fibres grown in the colonies; and in 1891 he entered into partnership with Messrs. Cross and Bevan, a connection which coincided with the discoveries relating to viscose, his name appearing on the original viscose patent in 1892. Subsequently he became a partner with Dr. H. P. Stevens, with whom he specialised in indiarubber.

Mr. Beadle was elected a Fellow of the Royal Society of Arts in 1891. In 1898 he read a paper before the Society on "The Recent History of Paper-making"; in 1902 he read a second on "Technical Education as applied to Paper-making"; in 1906 he read a third on "The Development of Water-marking in Hand-made and Machine-made Paper," for which he received the Society's silver medal; in 1908 he read a fourth, entitled "Some Observations upon the Underground Water Supplies to the Thames Basin"; and again, in conjunction with Dr. H. P. Stevens, he read a fifth on "Hand-made Papers of Different Periods" in 1909, and a sixth on "New Sources of Supply for the Manufacture of Paper" in 1913. He also took part in discussions on various occasions.

GENERAL NOTE.

Tin Output of Malaya.—In view of the fact that so much is being said by local European miners regarding the ever-decreasing tin output of Malaya, it may be of interest, says the *Times of Malaya*, to note that the world's production of tin at the present time is 110,000 tons a year, 60,000 of which are produced from ores mined in the British Empire, whilst close on 47,000 tons of this amount came from British Malaya and the majority of the 47,000 tons from the Perak. It is also interesting to note that the United States is the biggest consumer of tin, our American Allies requiring very large quantities of tin plates.

Correction.—The name of the deceased Fellow of whom an obituary notice appeared on page 769 of the *Journal* of October 5th was incorrectly given as John Chalmers Reid. It should have been John Reid Chalmers.

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FRIDAY, OCTOBER 19, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

COLONIAL SECTION COMMITTEE.

A meeting of the Committee of the Colonial Section was held on Friday afternoon, the 12th inst. Present:—

Lord Blyth (Chairman of the Committee); Octavius C. Beale; Earl Brassey, G.C.B.; Richard Ernest Brounger; Edward Dent, M.A.; Sir Walter Egerton, K.C.M.G., LL.D.; Major Edward Humphrey Manisty Leggett, R.E., D.S.O.; George Wilson, C.B.; with G. K. Menzies (Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Section).

EXAMINATION MEDALS.

The Court of the Worshipful Company of Clothworkers has renewed the grant, which it has hitherto voted for certain special prizes, in order to provide the medals to be awarded at the Examinations in 1918.

A FURTHER THREE YEARS' FLYING EXPERIENCE.*

By Captain B. C. Hucks.

I think I am right in saying that through the war aviation has advanced more than it would have done in eight or ten years of peace conditions. In fact, the rate of improvement in aircraft is so fast, so alarmingly rapid, that it is almost impossible for manufacturers to keep pace, for it seems that by the time the latest and most efficient type of machine is manufactured in sufficiently large numbers to gratify half the requirements of the Services, that type is out of date and obsolete.

A pilot has only to take a short flight on a 1914 type machine and then fly the latest 1917 pattern as a comparison to appreciate this colossal advance.

The advance seems to have been along, one might say, quite conventional lines—that is, improvements on what might be accepted as standard designs—and no good results have been obtained from any departure from that standard. Perhaps the furthermost departure from what I call standard, and that is very slight, has been the triplane. The results obtained with the quadriplane have not justified the experiment.

During the past three years the first marked improvement, to my mind, which asserted itself was the inherently stable machine, attained apparently by such slight detail alterations as sections of planes and elevators that it required an experienced eye to detect a stable or unstable aeroplane by casual inspection when standing together. Then came the synchronised timing gun-gear which enabled the machine guns to be fired through the propeller on tractor machines. This device is really so simple that one is at a loss to understand why it had remained so long undiscovered. It had the effect of giving the tractor type of machine a new lease of life; although a more efficient type aerodynamically than the pusher, it had been falling into disfavour as a fighter on account of the inability of the pilot to shoot straight ahead of the machine.

Improvements in engines, to my mind, are responsible for present-day performances to a far greater extent than improvements in machines, chiefly through sheer increase of horse-power. And cases have occurred where certain obsolete types have been made serviceable simply by fitting an improved type of engine.

The improvements in the machines themselves seem to have been limited to details, such as wing sections, attention to head resistance, soundness of construction, etc.

I will not attempt to discuss the future of aviation; but, setting aside the boundless commercial possibilities, I am more and more convinced that if we find it necessary to keep up an

* Extracted from a paper read before the Aeronautical Society of Great Britain on June 6th, 1917.

enormous Navy, say a two-Power standard to protect our island, it will be essential to maintain at least the same standard in the air. That in itself guarantees a colossal future for aeronautics.

Difference in Machines.

I have flown many different types of aeroplanes, and considering the extraordinary variations in the types the difference in the actual piloting of any modern machine, to my mind, is remarkably small. I am of the opinion that a pilot who is thoroughly efficient with any particular type will in a very short time be master of any.

I find that, on stepping out of a very fast small scout into a really big twin-engine machine, the difference in the manner of piloting is very slight compared with the vast difference in the machines. Precisely the same methods are employed, the same trouble and risks are to be avoided: the chief characteristics seem to be that the smaller and faster machines are more difficult to land, but are easier to handle in the air. In the case of "crashes," the larger and heavier the aeroplane the less damage is likely to occur to the occupants, as a tremendous amount of the impact is absorbed by the machine. Very much larger and heavier machines than those at present in use might be comfortably flown single-handed, no extra effort being required for the controls, provided the controlling surfaces are properly balanced.

To the lay mind it might seem that with such contrasts in the outward appearance of the smaller and larger machines, it would be necessary to train pilots specially and extensively for each type, but in my experience this is not so. I certainly think the best results are obtained when pilots are allowed to specialise. This, however, I understand has many drawbacks on active service.

Crashes.

Crashes are mainly due to three causes, viz., engine failure, faulty piloting, and faulty machines. Engine failure undoubtedly is responsible for most of the crashes, often because of the hopeless unsuitability of the landing ground at the pilot's disposal. To many pilots engine failure is most disconcerting, and it is then they are called upon to use rather more judgment and skill, so that even with a fairly suitable landing ground available they very often crash. In my experience, embracing the testing of hundreds of new machines, it is seldom that a serious defect in the engine "lets one down"—it is nearly always due to a small detail. I think I have had to make more forced landings through failure of the petrol supply than all the other troubles combined. This is due more often to failure of the pressure feed than to a choke in the supply pipes, and very seldom to severed connections in the feed system.

Because of the absence of a float chamber to the carburettor in the rotary engine, even a variation of the petrol pressure is more serious than in the rigid stationary type. In the former case, the amount of petrol that gets to the motor is controlled by the pressure and a fine adjustment. If the pressure increases unduly the motor chokes from overrichness of mixture; on the other hand, if the pressure drops away the mixture is unduly weakened. This variation can be controlled by the fine adjustment to a large extent; but when that limit is exceeded the engine will fail. Most of the trouble seems to be caused by failure of the pump, which in some cases forms an integral part of, and is driven by, the motor; in others it is a separate unit, driven by a small airscrew. These failures are usually through valves sticking up and pistons becoming dry. Other causes of failure are in the relief valve not being pressure tight or sticking down. At any rate, the present system of pressure feed, to my mind, is such a bugbear that it is high time something was substituted.

As far as the non-rotary motor is concerned, to my knowledge this matter is being tackled. I have been flying recently a machine fitted with a petrol pump in place of the air pressure pump, the petrol being pumped direct from the main tank to the carburettors, and the surplus is returned to the tank through an adjustable spring-loaded relief valve, so that petrol is delivered at any desired pressure to the engine. So far it has proved most satisfactory, with this advantage, that a punctured tank does not put it out of action. Dirt in the petrol tank accounts for quite a large proportion of engine failures in new machines. This form of trouble ought to be avoided. It is an important matter which manufacturers should be made to recognise and a very thorough system of tank washing employed before installation in the machines.

The dirt in the tank usually takes some time to work its way into and accumulate in the feed pipes or filters sufficiently to choke them. The machines are often by that time delivered by air by pilots, who are none too familiar with them, and consequently engine failure means a good chance of crashing.

I remember having four forced landings while delivering a new B.E.2C. from Farnborough to Dover on this account. Another simple cause of engine failure which might easily be guarded against, is that petrol cocks in many cases have no definite locking device to ensure that they remain in the open position during flight; consequently they are liable to vibrate into the "off" position, thus cutting off suddenly the petrol supply. Many instances have come to my notice where petrol cocks are fitted in such a manner that the tendency is, through the weight of the cock lever, to fall shut instead of the reverse. This is such a simple, and yet such an important point that it really is surprising mistakes like this are continually allowed to be made. I have had engines cut out suddenly on three occasions during the past two months from this cause alone; one meant a forced landing because the petrol cock was not accessible to the pilot, the other two were opened again in the air. It often leads to serious results as the petrol fails suddenly, and it is seldom that the cause is discovered before the forced landing is made. Having a somewhat limited time at my disposal this evening, I will not touch on what I have found to be other causes of engine failures, but I can assure you that, as far as my experience shows, they are a small proportion compared with those due to petrol supply, and improvements in this direction will reduce engine failures enormously.

Errors of judgment, or faulty piloting, account for nearly, or, perhaps, quite as many crashes as engine failure.

The most common error made, even by experienced pilots, is losing flying speed on a turn which starts a side slip, and given sufficient height, terminates in a nose dive, or the more serious predicament, a spin. This mistake is often made under the stress of circumstances, when engine failure calls forth extra effort on the part of the pilot to reach a certain landing spot. The trouble is nearly always incurred by turning too flatly until the wing drops and the machine side slips, generally in the effort to get into more suitable ground than that available straight ahead. This is always a dangerous manœuvre, and in nine cases out of ten when smashes have resulted, probably less damage would have been caused had the pilot kept his machine from turning and pancaked straight ahead. I have found that most of the later type machines can be stalled (*i.e.* speed reduced well below flying speed) without any risk of side slipping, provided they are kept in a straight course and laterally level, as they will automatically drop the nose as soon as the speed becomes so low that the elevators have little or no effect. Most of the serious accidents start at a height insufficient for the machine to get out of its side slip before striking the ground. Others strike the ground at the later stage, usually a nose dive, but in some cases a spin. If sufficient height remains after the machine assumes a nose dive, there is no reason why it should not be pulled out and a normal glide resumed; but in the other event, although it is possible to get out of a spin, it is a far more difficult proposition than the instinctive manœuvre of pulling up out of a nose dive.

A spin is the extraordinary turning movement that some machines only too readily take up after being stalled on a turn, or being turned too flatly, even with plenty of flying speed. This is due to the machine suddenly meeting the air a great deal out of the parallel with its longitudinal axis either through side slipping, skidding, or yawing in the air. Having had more than one involuntary spin, but having been fortunate enough to have sufficient height to get out again, I feel the matter is not to be treated too lightly. The position a machine assumes in a spin is a rapidly revolving side slip or a fairly steep spiral dive, with this rather serious drawback that the more one tries to pull it up by means of the elevator the faster it spins. No matter how high one is, if one persists in trying to pull it out in a normal way, it will remain out of control because the elevator has now become the rudder, and instead of pulling it out, increases the speed of turning. If the controls are abandoned the machine will come out of its own accord, but personally I have always found the best and quickest remedy for spins is to straighten the rudder and shove the joy-stick forward; a clean nose dive will then result out of which the machine can be pulled.

I think in the matter of spins, prevention is better than cure, and it is up to the designers to see that their machine is of the non-spinning type, as, however quick and clever the pilot may be in applying his pet remedy, he may not have height enough to do so, and the results are usually disastrous.

The errors in judgment which are made in landing account for crashes galore, but these fortunately are usually a small matter compared to those mistakes made in the air, seldom resulting in more than a smashed landing chassis.

Flying experience is the only remedy for this particular fault.

Landing with the wind will sometimes end in a crash through the machine overrunning the limit of the landing ground; whilst landing side to wind will buckle wheels and wreck chassis. Neither of these troubles is always the direct fault of the pilot.

An easily distinguishable standard type wind-vane on every recognised landing ground would considerably lessen crashes from these causes.

Accidents directly due to faulty construction of the aeroplane are fortunately comparatively rare, but when they happen the results are often fatal. They occur, however, even on standard types. In some cases the aeroplane is not entirely at fault, as in these days of heavy high speed efficient machines, which offer so little head resistance, and attain colossal speeds on diving, it is an easy matter for the pilot to increase the load beyond the highest factors of safety. One has only to consider the load on the wings of a machine dived at 160 m.p.h. when it is pulled out with a heavy hand.

Constructional failures of machines in the air can sometimes be traced to damage inflicted by imperfect landings, usually to the back part of the fuselage in the region of the tail skid. This gets overlooked, and subsequently the tail gives way under any extra stress whilst flying.

I should like here to be permitted to submit a suggestion for the consideration of our chairman for what it is worth, *i.e.* that a detailed record be kept of every engine failure, forced landing or accident of every kind and description that happens, at any rate, at all home stations. These records to be collected and classified, so that valuable data may always be available. However, some such system as this may already be in operation.

Training of Pilots.

I now come to a few points which might be brought forward from my experience of the instruction of pilots. I think that a great deal of time and expense might be saved if some form of medical test were applied to prospective pilots, such as I understand is done in France, where the effect of sudden shocks upon the system of the candidate is recorded by mechanical means, and other tests are made which are supposed to give a fair indication at once of the medical fitness and the possession of the necessary qualities, such as nerve, judgment, and the presence of mind required for the making of a pilot.

There are many pupils on whom a lot of time and material has been wasted in the endeavour to make pilots of them, who simply do not possess these ordinary qualities, and it is not until they have had smash after smash that it is discovered they simply have not got it in them. Now the French method should weed out the non-suitable candidate beforehand.

Personally, I consider that the nearest equivalent to the art of flying is that of motor-car driving: a person who thoroughly understands and who can drive a car really well should possess the qualities required for piloting an aeroplane. General Brancker, in a paper he read a short time ago before the Aeronautical Society, mentioned a good horseman as the type possessing the necessary qualifications. I agree that good hands, a good head, steady nerves and judgment are essential qualities, all of which should be found in a good motorist, with this advantage, that the good motorist is more likely to be naturally mechanical, a faculty inborn and not easily acquired, and so important in the matter of flying.

Time and material would be saved, in my opinion, if the modified "penguin" type of machine were more generally used for the very earliest training. I refer to the small-powered machine, incapable of leaving the ground, but designed solely for taxi-ing about the aerodrome, which was generally in vogue at the Bleriot Schools before the war. On this machine the pupil can be loosed off alone immediately after preliminary explanation with comparatively no risk, and at the same time he would get used to controlling his engine, have plenty of practice in the use of that important control, the rudder, and lastly, but not least, he would have to be left to his own resources, use a little initiative, and get used to the noise and wind from his motor. This type of machine might be modified in such a way that the other controls might be brought to play an active part in piloting the "penguin" over the ground. The whole fuselage and wings might be supported independently of the landing chassis (or, rather, the rolling chassis) in a sort of gimballs, so that it could be banked and elevated by the control lever whilst running along or turning. I think an hour's taxi-ing on a machine of this type would, as a preliminary, be of more assistance than the same amount of dual control, as the pupil would know at least more about the use of his rudder.

The question which is the best type of aeroplane to use for instruction in actual flying, and

whether it should be stable or not, is a very debatable point. I do think, however, that the less efficient, within certain limits, the early training machine is, the better and sounder will be the elementary knowledge and experience gained by the pupil. Such experience is likely to be very valuable when, later in his career, he is confronted with engine failures or similar predicaments, where his reserve of engine power will no longer cover up his multitude of sins in piloting. To illustrate this point, let us assume that there are two pilots, A and B. A has qualified for his Aero Club certificate on a box-kite, *i.e.* early Henry Farman type biplane, fitted with 50-h.p. Gnome. B gets his certificate on a much more powerful machine, one that can climb quicker, and can even be turned and climbed a bit at the same time. He knows this is so because he has done it on his last flight. But A finds that to get round really comfortably on his, he is compelled to drop the nose a little, as it feels a little sloppy otherwise. At a later date, on valuable service machines, both A and B have engine failures. A lands successfully, B crashes badly through turning too flatly. A has learnt from the beginning that he was always on the safe side in dropping her nose a bit on a turn; B always thought it unnecessary.

Personally, I do not think that the stable machine is the best for training. If it is considered so on the score that once in the air it will look after itself, and so reduce the chances of the pupil crashing, then we have only to assume for the sake of argument that a self-landing training machine has been devised that will automatically land itself correctly, do away with the smashes on landing, and ultimately, with a few more improvements, all the pupil need do would be just to sit still and take the air, as everything would be done for him; but after many hours of joy-riding on this super-school machine, he would have learnt very little about piloting. For securing Aero Club certificates for pupils at so much a head as a commercial proposition, this sort of machine might be excellent, but the unstable machine should be used as the basis of training to get the best results in the end.

I now come to another question, over which there is a deal of controversy. It is the use of instruments for training. I consider instruments as valuable accessories to any machine, but only under certain circumstances are they necessities, and in training they should not be regarded as indispensable. It is the wrong system, in my opinion, for the pupil to be made to rely on them too much. Although flying is largely a mechanical procedure, there is a tremendous lot of the personal sensation and feel that the pilot should acquire which, when once acquired, will take the place of practically any instrument devised. For instance, could an ice-skater learn to do the outside edge merely by looking at a bubble of a spirit-level fixed in front of him? I should say no, but once he had acquired the feeling that he had correct balance, which only practice can give, he will make his sharp turn on the outside edge at the correct angle better than any instrument could show him. Therefore, I say, let the pupil acquire without delay that naturally instinctive feeling so absolutely essential for a good pilot. Whilst he is taught to rely on his instrument too much to climb, turn, or even try and land, he will be long, if ever, in acquiring the art that will make him independent of instruments.

Personally, I seldom use an instrument as an assistance to piloting. Do not assume that I am sneering at instruments; in fact, as I have stated, there are times when they are a necessity. In fact, I am going to suggest that one more instrument be fitted as a standard equipment, an instrument to reduce the risks connected with flying in clouds. It may not generally be known that there have been such a large number of fatal accidents during the last three years entirely due to flying through clouds, and I consider this subject wants going into pretty carefully. The accidents to which I refer have not been due to a want of height; the machines have become hopelessly out of control. I will give you an instance which happened to myself a few weeks ago in the West of England. You will then realise why I consider this is a serious matter requiring particular attention. I set out on a very cloudy, windy day to do a test climb to 10,000 ft. on a late type two-seater. I had so often on previous occasions succeeded quite comfortably in reaching this height in spite of cloudy, overcast days by pushing up through the clouds, usually only a matter of a few minutes, into bright sunlight and the bluest of skies, and, after reaching the desired height, coming down again through the clouds, having flown by compass and time. On this particular day, however, the wind was very gusty, and on reaching 1,200 ft. we got into dense rain cloud, but carried on to beyond 5,000 ft., still in the cloud, when the compass apparently began to swing (really it is the machine that begins swinging, not the compass), and

efforts to check the compass had the effect of causing it to swing more violently in the other direction. The air speed then rushed up far beyond normal flying speed; all efforts to pull her up checked her only slightly; then the rudder was tried, back went the air speed to zero; there was an unusual uncanny feeling of being detached from the machine, and I knew her to be literally tumbling about in the clouds. All efforts to settle down again to a straight flight seemed to be unavailing, until we emerged from the cloud very nearly upside down. Assuming control again was then an easy matter. This sort of thing has happened to me more than once, and, in the Flying Corps vernacular, "it puts the wind up you," and it has happened many times with other pilots. In some cases they emerge from the clouds in a spin, others are known in which the planes have collapsed under the strain of the sudden pull-up from the vertical nose dive. A few days ago, a squadron commander told me that on one occasion when in France, everything loose in his machine fell out whilst in a cloud. A week or so ago, on the South Coast, a machine disintegrated in a cloud and the main planes landed half a mile from the fuselage. From my own experience, I know this is a very unpleasant state of affairs, and in consequence I avoid clouds when possible.

Let us try to examine the cause of this. First of all you must realise that in a cloud you see nothing whatever but your machine around you. There is no fixed point visible. The only means by which you can tell if you are flying in a straight course is by your compass and your air speed. The compass should give you your direction horizontally, your air speed your direction vertically. The first thing that happens, and very readily too, if windy and bumpy, is that your compass card will begin to move slightly. It really appears to you that the compass was suddenly affected by the cloud, and you are still flying straight ahead. How often you hear a pilot say that as soon as he got into a cloud his compass started spinning! The moment the compass starts moving it requires extremely delicate ruddering to get it back to a steady position; in fact, one invariably over-corrects the compass movement, and so the trouble begins. Once the compass starts on a good swing, I have found it nearly an impossibility to get it steady again until out of the cloud. Before your compass starts to move your machine has already started to turn. You rudder the opposite way to check it, over-correct it, and turn sharper the other way on to a bank turn; then the nose drops and speed goes up. Pulling back your elevator lever has little or no effect, for if you are banked above an angle of 45° the elevator becomes the rudder. All this occurs without the pilot being in the least bit aware of the position that his machine is taking relative to the ground. The instruments available are of little service once he loses his control.

Of what use is his air speed indicator to him indicating 150 m.p.h. if the machine is on a spinning spiral and he imagines that he is merely descending too fast on a steep, straight glide? He naturally tries to pull up, but with no effect. The bubble does not help him, as centrifugal force will send that anywhere. It may be argued that if a stable machine is left alone under these circumstances, it will right itself eventually and assume a normal glide. It very likely would if the pilot could steel himself to let it entirely alone, but before it did so it would have to be left to do a sheer vertical nose dive for some moments, and in these days of big weights and little head resistance one is liable to attempt to pull out too suddenly from the dangerous high rate of speed attained on this dive. What I want to see fitted is an instrument which will show a constant vertical or horizontal line and be independent of centrifugal force. I have no ideas upon the subject nor suggestions as to how this is to be brought about, unless something in the nature of a small gyroscope driven by an air-screw could be employed in some way to meet the requirements of flying in clouds, but until something is provided so that the pilot can see a fixed line, I think we shall continue to have accidents from this cause.

There are lots of other points that I should like to touch upon, but as my time is getting short I shall now deal with the subject of flying at great altitudes as I have found it. The most marked development in the modern machine is its extraordinary capacity for climbing to a great height in a short time. At the beginning of the war the average height flown on active service was 4,000 to 5,000 ft., simply because few of the machines then in use with the impedimenta carried could get much higher. To-day a height of 20,000 ft. is, I believe, on certain occasions reached, and it is fairly certain that if progress continues at its present rate, heights a great deal beyond this figure will be reached as a usual thing. These great altitudes bring forward

many difficulties which will have to be seriously considered. The first trouble in the winter will be the extreme cold to which the occupants will be subjected unless they are protected by special cowling which will gather in the warmth given off from the engine. This, to a certain extent, is the natural advantage obtained in the tractor. The question of the difference in the comfort of machines in this respect was shown to me in a very marked manner last winter. I was testing the fall-off of engine power at a height on a tractor two-seater, in which it was specially arranged that the warm air from the radiator and engine passed along the fuselage to the pilot, and then to the passenger, and although at a height of over 21,000 ft. with the thermometer below freezing at ground level, I did not suffer in the least from the cold, neither did my passenger, who sat behind, complain until we shut off to descend. As a contrast to this, a few days later I was on a single-seater scout at an altitude of 17,000 ft., and although it was a tractor with a rotary motor, I suffered intensely from the cold, and became so numbed that my vitality must have been something akin to that of a dormouse under the snow, and, in spite of being well gloved, I had frostbitten finger tips, which pained for many days afterwards. Surely this is a very inefficient state for a pilot at the front who may have to take on an air fight or other exacting work? Put two pilots up to a great altitude, one kept well warmed and comfortable, the other half dead with the cold, and it would be easy to surmise which would be more likely to do the best work.

I really believe it is more by accident than design that the pilot or passenger has benefited at all in the past from the heat of the engine, with the exception perhaps of the case of the late S. F. Cody's machine. He purposely placed the radiator of his pusher in front of the pilot to keep him warm. I know from my experience when flying in France in the cold weather, that the discomfort owing to the extreme cold became intense when flying only at 6,000 ft. on a two or three hours' reconnaissance flight. This is a point to which designers should give attention, especially as machines are now easily capable of reaching great heights. During summer weather conditions would probably be tolerably comfortable, but in winter it would be well nigh impossible unless better arrangements are generally made.

Cold also affects the motor pretty seriously. This is more noticeable with the water-cooled type. Unless some provision is made for blanketing the radiator surface at heights, it becomes far too cold for efficient running. Cases are known of the freezing of the water system on a descent from a great height, with pretty serious results to the motor, as well as the difficulty of getting the engine to run again efficiently through being too cold to effect a landing. In the future war machine the pilot must have a very wide range of control over the water-cooling system.

The next point for consideration is that of carburation. As the atmosphere decreases in density with the increase of height, so the motor gets less air, and unless the amount of petrol that gets to the engine is decreased in proportion to this decrease in the air, then the carburation goes all wrong through richness of mixture. Many machines with stationary type motor are fitted with what are called altitude correctors, an arrangement whereby the atmospheric pressure is decreased in the float chamber and by offering more resistance to the suction of the engine, reduces the amount of petrol flowing through the jets. As far as my experience goes, with this form of fuel regulator there is insufficient range of control, and the effect is very slight. I tried the other day a corrector whereby the jet apertures were controlled direct by the pilot, which is the best arrangement of this nature I have yet come across. As the altitude increases the jets are closed, so maintaining fairly well the engine revolutions. On a climb to 15,000 ft. the engine only lost twenty-five revolutions per minute, principally because the mixture could be easily controlled and kept reasonably correct.

I will now touch lightly on effects that I have experienced on high flights. I have found the effect of high, *i.e.* rarified, air to be felt slightly at about 10,000 ft., increasing with the altitude. Breathing becomes affected, respiration shorter and quicker, there is a curious oppressive sensation and a bulging feeling in the head at the height of about 20,000 ft. I am told by a medical friend who has made rather a study of the subject that there is always a risk of a sudden collapse, and oxygen should be used whether the aviator feels fit or not. Of course, the effect felt varies considerably with individuals, and with the state of one's health. About eighteen months ago I suffered slightly with my heart, and found I could not get very high without feeling giddy, and after returning from a flight to 12,000 ft. I had palpitation, which lasted until the following day. In consequence I had to abandon high flying until

treatment got me fit again. This year I have made a number of high flights, and have felt no ill effects whatsoever; in fact, I find the more one gets accustomed to going up high the less the effects are felt. I am told that this also is the case in mountaineering. I can remember the unpleasantness of my first flight to 15,000 ft. It was very marked, especially the pain experienced in the drum of the ears on descending. The fact that a flight now to 21,000 ft. or 22,000 ft. does not have so much effect I put down entirely to acclimatisation. I use oxygen as a precaution when ascending beyond 20,000 ft., for the previously mentioned reason. A small bottle is carried, fitted with a special reducing valve, with is fixed in the fuselage within easy reach of the hand. No special regulation is required, as it is set to pass only the necessary amount of gas into the face mask which acts as a mixing chamber, with its inlet and outlet air valve. The apparatus weighs 16 lb., and contains sufficient oxygen for one hour's continuous use. After reaching 20,000 ft. I find it is only necessary to use the oxygen intermittently, and accordingly I simply hold the mask after turning on the gas over the mouth and nose and take a few breaths of it, perhaps every half minute. The effect to me is remarkable; most of the oppressive feeling vanishes, and, excepting for the unpleasant bulging feeling of the head, which you experience with a bad cold, the sensation is one of suddenly being again at ground level. The only after-effects upon landing from these high altitudes are that you seem to acquire a pretty good thirst, due, I suppose, to the use of oxygen. If the speed of climb continues to improve at the rate it has for the past three years, it looks as though aviators will become subject to what is known as "Caisson Disease." This is due, I am told, to the sudden reduction in atmospheric pressure, such as divers are subjected to when they come to the surface from a great depth, owing to the nitrogen which has been absorbed by the system, in proportion to the atmospheric density, forcing itself too rapidly at any lower pressure from the system.

THE GERMANS IN SURGERY.

In the inaugural address which he delivered to the Royal Society of Arts in November, 1915, Sir Dugald Clerk dealt in a very effective way with the claims of the Germans to be pioneers in scientific discovery. "An examination of the leading scientific work of England shows," he said, "that it is always brilliant and far-reaching, and early in the field. Practically all fundamental discoveries in science have originated in England, France, or Italy. Germany's scientific work is undoubtedly of an important kind, but it is always of what may be called the 'pedestrian' type; hard-working and plodding, but with little foresight or brilliancy."

Sir Dugald Clerk pressed home his point to the hilt by a careful summary of what has been done by different nations in such various branches of science as heat, electricity, light, atomic and molecular knowledge, chemistry, telegraphy, and internal-combustion engineering work. A similar investigation of the German claims to pre-eminence in surgery has now been made by Sir Berkeley Moynihan, C.B., M.S., F.R.C.S., who contributes an extremely interesting article entitled, "The Institutes of Surgery," to the *British Medical Journal*.

"Men," he says, "are apt to be taken at their own valuation. What is true of a man may be true of a nation. It is beyond dispute that Germany, as a result, in part, of the arrogant repetition of her claim to intellectual superiority over all nations, and in part, of a tolerant and sometimes disdainful silence or acquiescence by others, has been accepted almost universally as the pivot and centre of the world's thought. My own realisation of this, in regard to surgical matters, was dramatic in its suddenness. I had been a student in Germany years ago, had lived with German students, and followed closely the work of German surgeons in several clinics. I had formed my own conclusions as to the value of the German contributions to surgical advancement, and nothing that has happened since the war began has altered in any way the opinions I then held. About five years ago one of the most distinguished of the Scandinavian surgeons, who had made a yearly pilgrimage to Germany of some weeks' duration, came to spend his surgical holiday in England. He lived with me for more than a month. I had always known him as a warm advocate of Germany's methods in surgical literature and practice, and of his intellectual contempt for most of the things which other nations had done. Of the work of these other nations he had learnt nothing at first hand; the little he knew had been distilled through the minds of German interpreters, and had been conveyed to him verbally on his frequent visits, or had been taken from the easily accessible German journals and text-books. At our first breakfast meeting

he told me of his immense obligations to Germany, of his schooling in her methods, of his devoted attention to the debates of the German Surgical Association; and he went on to say that he felt it almost an act of treachery to spend his surgical vacation in any other land. And then he gravely announced that 'Of course, all surgical advance in the last fifty years has come from Germany.' To that kind of fervid unrestrained assertion the most fruitful denial is given by a questioning assent. I answered: 'Of course; tell me of one.' Whereupon I had to learn from him that the introduction of the antiseptic system into practice was wholly to be attributed to German research, adoption, and advocacy. Now this claim, so confidently made, and, I hope I may say, so utterly shattered in the debate which followed, is precisely the type of claim which Germany herself has always made. Most of the great ideas, she tells us, originated with her; those that by chance arose elsewhere, would never have come to fruition but for her acceptance, and for the authority with which thereby they were endorsed."

Sir Berkeley Moynihan then proceeds to state, in some detail, the facts as to the development of the antiseptic system. They begin with Latour's discovery in 1836 of the living character of the yeast cells by which fermentation was produced—a discovery which, it is interesting to recall, was denied both by Liebig and Helmholtz. Latour's work was confirmed and extended by Pasteur, and Pasteur's work again was confirmed and extended by Lister. In fact, as Sir Berkeley says, "the exploratory work, the pioneer work, all that was original, was done by a French observer and an English surgeon. The exploitation of this work, it is true, was almost at once eagerly and widely carried out by the surgeons of Germany . . . . but it is notorious that, in carrying the Listerian principles to their logical conclusion in practice, Germany fell far behind other countries."

A cursory review of the history of surgery does not bring to light any German names among the masters of the craft. Vesalius of Brussels laid the foundations of anatomy; Harvey made possible all later researches in physiology; Morgagni "brought together the statics and dynamics of medicine, founded pathology, the science of the causes of error in the human machine"; Hunter first made surgery a science; Morton and Warren of Boston, and Simpson of Edinburgh, by the discovery of ether and chloroform robbed surgery of most of its horror; while Pasteur and Lister, as already mentioned, changed the whole history of the art.

An analysis of the history of abdominal surgery leads to a similar conclusion. The pioneer of this work was Houston of Glasgow, followed by John Hunter and William Hunter, McDowell of Kentucky, Spencer Wells and Lister. "The literature emitted by Germany upon the subject of gastric diseases," writes Sir Berkeley, "is vast in quantity, prolix and turgid in style, lacking insight and interest, and almost utterly devoid of inspiration or original thought. It is, however, a complete record of the progress made and of the knowledge gained by all the workers in every corner of the field. The Germans are seen in their most characteristic phase as gleaners and harvesters. The seed has been sown by others; it is they who have guarded the crop, garnered it, gleaned every straw of it, and stored it in vast and ugly chambers."

In the surgery of the brain and cord the principal German names are Fritsch and Hitzig, who demonstrated in 1870 that stimulation of certain areas upon the cortex produced co-ordinated movements, in distinct groups of muscles, on the opposite side of the body. These observations were, of course, important, but against them is to be set the enormously greater work of Broca, Hughlings Jackson, Ferrier, Macewen of Glasgow, Victor Horsley, J. F. Faure, Sherrington, and Head.

"What, then," concludes Sir Berkeley, "has been Germany's part in all the astounding progress of modern surgery? It has been the same in surgery as in every other science. Almost all fundamental discoveries in science, Dugald Clerk tells us, have originated in England, France, and Italy. In capacity for original thought the German mind is lacking. The brilliant and happy inspiration, the penetrating insight, the new vision are things for which we seek almost in vain in all German scientific literature. The fertile new thought giving a fructifying impulse to the work of others is rarely indeed of German origin. The German mind is of quite a different order. It is avaricious, industrious, methodical; it collects, if it does not accurately appraise, the work of others. It tabulates and registers and explains; it furnishes an intricate analysis, and illustrates by copious reference any subject with which it may deal. The new idea, originating almost always elsewhere, is given eager hospitality,

is dissected and discussed at inordinate length; it may be put into practice with various alterations of technical procedure, and before long be claimed as a home product. For this act of intellectual dishonesty many of the German writers were not to blame; for a study of the literature of almost any subject in medicine chosen at random will show the amazing infrequency of any reference to the English or American literature, and very few indeed to the French. Thus in Riegel's work, the article on ulcer of the stomach has four and a half pages of references: seven references are to English writers, five are to papers by Riegel himself. The name of Brinton is not even mentioned in this list, and yet it is probable that in his small book there is more of the truth of the matter of gastric diseases than in all the interminable treatises published by all the German physicians since his death. This almost exclusive reference by German writers to the works of their own countrymen was greatly helped by their publishers. In the last few years I have heard more than once from friends of my own in the medical profession in Italy, in Spain, and in Norway, that it was impossible to obtain from an English or American publisher a copy of any medical work on approval. A surgeon, desirous of seeing a new work in any special department of surgery, could only do so by purchasing the book outright and taking his chance as to the contents being to his liking. Any German publisher would send him all the books or journals he desired to see on approval. The copies of new German works on medicine were always sent to the editors of foreign journals for review. A new medical work in English was rarely, if ever, sent to Scandinavian countries, to Spain or to Italy, and to France or to Germany only in the case of a work of outstanding importance. To put this matter quite briefly, reference could always and quite easily be made by foreign physicians or surgeons to works published in Germany. It was difficult to hear of English works, and almost impossible to obtain them except by a speculative purchase. To the claims which Germany makes for intellectual supremacy we may therefore, speaking of scientific surgery, retort by a firm and flat denial. Not one single discovery of the first importance in the science or in the art of surgery can be placed to the credit of Germany. Nor, if we omit the Semitic element in the Germany of to-day, should we expect this to be the case. For the German mind is deductive; it is patient, laborious, massive; but it is not original. The German is not an innovator, but a renovator; not an explorer, but an exploiter; not a creator, but a collector."

BRITISH DYES IN EGYPT.

By W. A. STEWART,
Inspector of Arts and Crafts, Department of Technical Education, Cairo.

The immediate effect of the war on the dyeing industry in Egypt was even more disastrous than was the case in India, because the quantity and variety of available vegetable dyes is greater in India than in Egypt, and more traditional knowledge of vegetable processes still exists in that country. In Egypt almost all vegetable dyes, with the exception of indigo and certain yellow plants, together with pomegranate skin, are imported from Persia and India, or from South America. Indigo is imported in large quantities also from India, but a small amount is still cultivated near Akhmim, in Upper Egypt, where the old vats for extracting the colouring matter exist in the same form that must have been used since the days of the famous Akhmim Coptic tapestries. Since the introduction of chemical dyes, vegetable dyeing has been very much neglected, except for certain types of silk Kaftan cloth and for figured waist belts. The more simple processes of cotton dyeing by the direct salt method have become almost universal, with the result that the sudden stoppage of supplies from Germany on the outbreak of war threw the whole textile industry into a state of panic. Prices of dyes rose rapidly to more than ten times their original value. In the case of certain cotton yellows and methyl violet, dyes previously sold at tenpence went up to thirty shillings per pound. These high prices for existing stocks caused a cessation of work amongst the weavers for a time, but it was soon found that the lack of imports was creating a demand for home-woven fabrics at prices which would allow of ample profits, even with dyes and cotton yarn at exorbitant prices. It should here be mentioned that the Filiature Nationale of Alexandria has proved of enormous benefit to the weaving industry by providing cotton yarn at reasonable prices, and it is regrettable that greater variety in counts and quality cannot be turned out by this company. For the cheaper varieties of cotton cloth the Egyptian dyers again tried vegetable processes, but with little success. Black, at no period of history a good dye by natural processes, was produced by acacia seeds, pomegranate skin and ferrous sulphate; but the shades were poor and the process long and costly to produce with fuel at a high price. Logwood extract was used, and also madder so long as it was obtainable; but these materials also rapidly rose to exorbitant prices.

During the early summer of 1916 the first samples of British dyes were obtained, and their processes demonstrated at the Bulak Technical

School to a few of the more important dyers. The result was an immediate and urgent order for direct cotton black, Congo red, and dional yellow for the Akhmim cotton weavers. This was the beginning of a rapidly increasing demand for the new dyestuffs. The dyers, at first afraid even to try any but German dyes packed in tins labelled in the manner they had so long been accustomed to see, would not look at the British dyes packed in plain black or brown paper. Once, however, they had been persuaded to see an experiment and been allowed to wash the dyed cotton, they were immediately won over, and it is a tribute to the excellence of the British product that more than one Egyptian dyer has told me, speaking of Congo red, that it is stronger and more fast than the German dye supplied to this market before the war. Certain acid dyes have also been introduced specially for dyeing black silk crepe, the universal outer garment of the Egyptian lady; but as yet there are not many dyers who understand acid dyeing, and for fine qualities of silk goods they prefer a long immersion in indigo and an after-treatment in pomegranate skin and ferrous sulphate. The dyers are gaining confidence, however, and the market is steadily growing; sulphur dyes have been tried in small quantity, and if sulphide of sodium was more easily obtainable it is possible that these dyes, so fast to light and washing, would secure a constant demand. In the short period of rather less than twelve months the British dye manufacturers have gained the Egyptian market, and it remains with them to hold it against competitors in the future. This they can do with care, if prices remain equal, for the Egyptian dyer is very quick to observe the strength and quality of his dye. It is useless, however, at present to supply dyes requiring any but the most simple and direct processes. Very few dyers understand other than the cold indigo vat process. In the large towns the Syrian dyers understand the use of aniline salt, bichromate of potash and the direct cotton dye methods with salt or sodium sulphate. In Cairo and Alexandria there are one or two dye establishments only with any knowledge of chemistry who might employ more complicated processes, but would probably fear to do so on the score of extra expense.

It should not be forgotten also that dyed stuffs in Egypt are subject to extremely severe tests from sunlight, and that unless they are reasonably fast to light they can have no possible chance there. If artificial indigo paste can be supplied, the whole Egyptian market will be in the hands of the British dye manufacturer; but here, as in the case of cotton dyes, there are certain restrictions that must be attended to in packing. The indigo dyers are scattered throughout the whole length of Egypt, and there is not a village that has not at least one dyer with one or two vats. These people are mostly very poor and they cannot afford to buy in large quantity. The paste must, therefore, be supplied in tins averaging from 3, 5, 10, or 15 kilos. Beyond this weight barrels or large kegs can be used for big consumers in the larger towns, but by far the largest market is the small dyer scattered throughout the villages.

COCO-NUTS AND COPRA IN THE DOMINICAN REPUBLIC.

There are no statistics as to the total area in the Dominican Republic planted with coco-nuts. These trees are grown to a certain extent all over the island, but the only locality where they are systematically cultivated is in the vicinity of Samana Bay. Practically all the country's exports of coco-nuts and copra are shipped from the port of Samana. It is estimated by those interested in the business that 8,500 acres of coco-nuts are planted in that region. The average number of trees per acre is 13, and the average annual yield of nuts is from 600 to 700 per acre, or 50 to 55 per tree. From a report by the United States Consul at Puerto Plata it appears that, while exports of both coco-nuts and copra have tended to increase during the last few years, the amounts are still small. No coco-nut oil is exported, although some is extracted at Samana by a local soap factory.

The coco-nut, although it is widely distributed, plays a relatively unimportant part as a source of sustenance in the Dominican Republic. It plays relatively an even smaller *rôle* in the exports of the country, of which it forms only a fraction of 1 per cent. There is said to be a considerable area of land suitable for growing this palm, but the heavy rain in some localities interferes with the drying of copra. The coco-nut trees on the island have also been visited by diseases which have caused considerable losses in the past. The cultivation of the coco-nut may increase in the future, but there is little reason to believe that it will ever become one of the important products of the Republic.

MOTHER-OF-PEARL.

The *Bulletin of the Imperial Institute* contains an interesting article on "Mother-of-Pearl Shells and their Uses, with special reference to the Australian Industry," from which the following particulars are taken:—

Sources of Shells.

The two principal species of pearl oyster furnishing mother-of-pearl are the large mother-of-pearl oyster (*Margaritifera maxima*, Jameson) and the black-lipped mother-of-pearl oyster (*Meleagrina margaritifera*, Linn.).

The large mother-of-pearl oyster inhabits the tropical coasts of Australia, Papua, the Solomon Islands, the Dutch East Indies, the Sulu Archipelago, and other localities in the Philippine Islands, Borneo, and the Mergui Archipelago.

Two principal types are recognised in the trade—viz., gold-lip and silver-lip. The former is characterised by a more or less golden colour

of the margin of the nacreous portion of the shell. The gold colour detracts from the value of the shell, as the silvery-white colour is most in demand for the best class of articles, such as knife handles and large buttons, so that gold-lip shell realises a lower price on the average than silver-lip. The principal sources of the silver-lip variety are Queensland, Western Australia, the Northern Territory, and the Ara Islands, the remaining localities mentioned above being characterised by the large preponderance of gold-lip shells that they yield.

M. maxima was formerly obtained in large quantities in shallow water by naked divers, and was even picked up by waders at low water, but is now chiefly fished for in deep water of 10 to 40 fathoms with the aid of the diving dress.

The price of this shell in the London market varies from £70 per ton upwards according to quality, the highest prices being paid for bold, clean shell, that is free from the attacks of boring animals, and calculated to yield the largest number of such objects as knife handles with the minimum of waste. Occasionally selected parcels reach a price exceeding the rate of £500 per ton; but £150 to £200 per ton may be taken as an average price for shell of good quality.

The typical form of the black-lipped mother-of-pearl oyster (*M. margaritifera*, Linn.) occurs around the tropical coasts of Australia and throughout the East Indies, being particularly partial to coral reefs and atoll lagoons. It is usually fished for in these waters by primitive methods, such as naked diving or wading on the reefs. The output is relatively small, and most of the supplies, unlike those of the more valuable *M. maxima*, are purchased in small quantities by traders from the natives who collect them. Farther east among the coral islands of the Pacific this species is represented by a larger and darker variety (*M. margaritifera* var. *Cumingii*, Reeve), known in the trade as the Tahiti, Gambier, or Penrhyn shell.

The price of black-lipped shell fluctuates greatly with the demand for "smoked pearl" buttons, fashionable for ladies' tailor-made clothing: the dark colour occurs on the lip of the shell and on the outer surface of the nacre. Occasionally the best qualities have reached prices exceeding those of the great white shell (*M. maxima*), but, as a rule, the average price does not exceed £60 per ton.

The Zanzibar shell (*M. margaritifera* var. *zanzibarensis*, Jameson), with copper-coloured margin, is the East African representative of the species, while on the west coast of tropical America it is replaced by a paler form (*M. margaritifera* var. *mazatlanica*, Huxley), which is used as a cheap substitute for *M. maxima*.

Other local varieties of this species are *M. margaritifera* var. *persica*, Jameson, from the Persian Gulf, known in the trade as the "Bombay shell" from the port through which it is shipped; and *M. margaritifera* var. *erythrea*, Jameson, or the Egyptian shell from the Red Sea. Both these varieties are large, bold, light-coloured shells, and are used for purposes similar to those for which *M. maxima* is valued.

It will thus be seen that *M. margaritifera* with its varieties is very widely distributed in the Indian and Pacific Oceans; and that, while *M. maxima* occurs in an area where the character of the water is to some extent influenced by the proximity of numerous islands with a heavy rainfall or with large rivers like the Fly River in Papua, the range of *M. margaritifera* is much more extended, and the shell reaches its maximum development in areas of high salinity, far removed from river influence, as, for example, in the atolls of the Pacific: it is, in fact, much more an oceanic form than is *M. maxima*, though occurring sparingly in the haunts of the latter. The economic bearing of this point has been emphasised in a paper, "Biological Science and the Pearling Industry," by Dr. H. Lyster Jameson (*Knowledge*, November, 1912, pp. 427–430), in connection with the unsuccessful attempts which have been made to establish *M. maxima* in atoll waters.

A less valuable source of mother-of-pearl is the Sici or Trocas shell (*Trochus niloticus*), which is of common occurrence all over the Fiji group of islands. These shells are gathered chiefly from the top of the sea-reef, few being found where the waves break or on the shore edge of the reef. They are taken in calm weather by diving. After a patch of reef has been worked a further collection can be made within a few days. This, together with the fact that specimens are taken on the seaward side of the reef, appears to indicate that these molluscs come up from deep water where probably they breed. Sici shells are worth from about £12 to £45 per ton according to size and condition, and are exported chiefly to France and Japan for button-making.

Among other shells used instead of mother-of-pearl may be mentioned the green snail shell (*Turbo marmoratus*) and the green ear and Ormer shell (*Haliotis tuberculata*).

Method of Collection.

Fishing for pearl oysters is now largely carried on by means of highly organised fleets of vessels. Such a fleet usually consists of a schooner or other vessel of 100 to 200 tons, on which the manager resides, and a number of fishing boats or luggers ranging from 10 to 20 tons, each equipped with a diving dress and pump. The oysters are fished by the luggers and brought on board the schooner or floating station by motor launches, and are then opened in the presence of the manager. Any pearls found are extracted, and the shells are then cleaned, marine growths being removed from their exterior and the brittle fawn-coloured lip chipped off. They are

afterwards sorted into grades and packed in cases, when they are ready for shipment to the London markets for disposal by auction at the periodical shell sales.

In some instances the boats are entrusted to divers, who, while normally servants of the owners, are for all practical purposes the lessees of the boats. The diver has to feed and remunerate the crew, and receives a "lay" of so much per ton of shell delivered to the owner. In such cases any pearls that are found in the "lay" become the perquisites of the diver.

ARTS AND CRAFTS.

The Design and Industries Association's Competition.—The committee of the Design and Industries Association deserve to be congratulated upon their latest enterprise. It was high time for something to be done to promote the cause of design: there are few things more attractive than a well-planned competition, and the terms in this case seem to have been thoroughly well thought out. It is distinctly stated that the competition is not limited to professional designers, and this fact, coupled with the statement that the fullest particulars will be given to the six competitors who are invited to enter for the final stage, suggests that the society are eager to attract not only the regular designers but also some new blood. The competition is to be divided into two stages. In the preliminary stage designs specially executed for the competition are not asked for. It is enough that the works submitted should be "for surface decoration in colour, and that they should be the signed work of the competitor." The designs in the final stage are to be for hand and machine printed fabrics, and the selected candidates will be asked to prepare designs to be executed by both processes. The promoters undertake to purchase at least one design in each class at twenty-one guineas and fifteen guineas respectively, and to give an honorarium of three guineas to each of the competitors whose designs have not been purchased in either class. These unpurchased designs will be returned to their designers. The names of the unsuccessful competitors will not be divulged, and the designs submitted will remain with the Association until returned. The regulations have evidently been drawn up by men who realise that good designers will not spend their time on competition work with the prospect of getting absolutely no return for their labour, and that they are shy—not without reason—of sending up work for inspection which may be copied or adapted without acknowledgment, to say nothing of remuneration. The one point on which intending competitors might possibly like rather more definite information is the composition of the jury. The regulations provide that the judges will consist of "three members of the Executive Committee of the Design and Industries Association and two members of the Textile Printing Trade." That is a rather vague statement. Apart from the doubt which it naturally raises as to which members of the Association will be judges, and whether they will be artists, or manufacturers, or distributors, or a combination of all these three, the natural query from anyone who has designed for any trade will be, "who are the two members of the Textile Printing Trade?" One imagines that as regard professional designers that is a question of primary importance. Of course, the regulations are so framed that the risk of the designs being improperly used has been reduced to a minimum, but even so, it is an instinct evolved by generations of difficulty which makes men hesitate to submit works to an unknown jury. However, the general scheme of the competition seems in every way admirable, and it is to be hoped that the appeal will meet with a thoroughly satisfactory response.

Art on the Hire System.—The Omega Workshops, Ltd., have taken advantage of the little exhibition of modern pictures and sculpture which has been arranged by Mr. Roger Fry at the Mansard Gallery, to advertise their scheme for the establishment of what they call a "Picture Exchange." The idea is that, in return for an annual payment of two guineas, subscribers shall be entitled to the loan of one oil painting (or two water-colours), which they are free to change every three months if they so desire, or to keep for a year unless the artist particularly asks for its return, in which case it will be replaced by another. The Omega Workshops undertake to keep on their premises at least fifty pictures from which subscribers may choose. The artist on his side will receive 30*s.* a year for each picture lent out. The pictures will be considered to be on sale, and, in the event of their being sold, the subscriber through whom the sales are effected and the Omega Workshops will each be entitled to 5 per cent. commission. The plan appears to be a very admirable one which should appeal to those who care for a certain type of up-to-date art. It seems, however, rather astonishing since it comes from the Omega Workshops, that it should hold good only for pictures. It would, of course, be rather more difficult to apply it to pottery, metalwork and the products of the other artistic crafts, but with a little thought it ought to be quite possible to work out a scheme which would be applicable to works of this kind. There would, naturally, have to be some special arrangement for insurance, but it would seem imperative that there should be something of this kind also in the case of pictures. With regard to objects coming under the category of Arts and Crafts, such an arrangement would have a

double advantage. It would enable those not in a position to buy such things to have something beautiful about them, and it would give the rich buyer a chance of seeing how an object which attracted him would fit in with the scheme of his house, and whether or no he wanted to live with it permanently. It is to be hoped that some such idea as this may commend itself, if not to the Omega Workshops —who, after all, cater for a strictly limited public, and who provide only a certain type of very modern productions—then by some other organisation which makes a somewhat wider appeal. It is not only painters who have usually a certain amount of unsold work on their hands, which they might be willing to lend in this way. It is really rather astonishing that amidst all the schemes set on foot for encouraging the artistic crafts something of this kind has not been tried before now.

GENERAL NOTES.

MINERAL WOOL.—According to the Melbourne *Age*, an extract from which has been forwarded by H.M. Trade Commissioner in Australia to the Board of Trade, a pure white mineral wool is being manufactured at Yarraville, a suburb of Melbourne, from basalt rock, or "bluestone," vast masses of which are found in the neighbouring district and Footscray. This is a new industry in the Commonwealth, and has been started by an American firm. The mineral wool has a staple of 1½ to 2 inches. It is said to be pure white with a fine metallic lustre showing through it, and in texture it is soft and pliable. It is easily adapted for engine packing, and is already in use in the Yarraville factories. It can also be moulded into sheets like asbestos. Only the shortness of the staple militates against its use for weaving. There is said to be a growing demand for it as an insulator for packing machinery or ice-chests, and as a substitute for asbestos.

NEWFOUNDLAND FISHERIES.—The seal fishery in 1916, according to a report on the trade of Newfoundland by H.M. Trade Commissioner, proved to be highly successful. The catch constituted a record one for the small number of ships engaged, eleven steamers bringing in 241,302 seals—an average of nearly 22,000 seals per vessel, the value reaching $642,463. In eight of these vessels the crews received from $91 to $167 per man, and the time occupied in this work did not exceed one month. The export of herrings nearly doubled during the year, a great demand for Newfoundland fish having sprung up in the United States owing to the falling-off of the North Sea catch and the establishment in Newfoundland of the "Scotch packing" system, whereby the herrings have largely advanced in value and favour. Efforts are being made to secure this trade permanently, which ought not to be a difficult undertaking, as the herrings obtained are equal in size and flavour to those caught in the North Sea. The trade in fish oils has also largely increased. The export of cod-liver oil in 1916 was 142,637 gallons, valued at $254,562, as against 47,170 gallons, valued at $35,837, during the previous year. The compulsory inspection of this oil by the Government has led to a much better quality being exported, and the prompt action taken to deal with careless manufacture has had beneficial results. The quality of oil exported, and passed by the Government inspectors, has been admitted by many high authorities abroad to be equal to the best oil produced in Norway. It is hoped that the market opened for this article may be held after the termination of the war.

CHEMICAL INDUSTRIES AFTER THE WAR.—The Minister of Reconstruction has appointed a committee to advise him as to the procedure to be adopted for dealing with the position of the chemical trades after the war. The committee consists of Sir Keith W. Price (chairman), Mr. T. Anderson, Mr. T. F. Brunner, Dr. C. Carpenter, Professor T. G. Lawn, Sir William Pearce, Mr. K. B. Quinan, and the Right Hon. J. W. Wilson, with Mr. G. C. Smallwood, of the Ministry of Munitions, as secretary. The officers of Government Departments have been appointed with the concurrence of their respective Ministers, and the other members of the committee at the suggestion of a representative meeting of chemical manufacturers. Dr. Addison has requested the committee to conduct its deliberations with a view to the creation of some organisation which should be adequately representative of the trade as a whole, and by means of which the trade may be enabled in future to continue to develop its own resources and to enlist the closest co-operation of all engaged in the chemical industry.

VICTORIA AND ALBERT MUSEUM.—A famous State bedstead from Boughton House, Northamptonshire, recently presented to the Victoria and Albert Museum by the Duke of Buccleuch, has been placed on exhibition in the Woodwork Galleries of the Museum (Room 54). The bedstead, with hangings and upholstery of crimson Italian brocade, enriched with gold fringes and ostrich plumes, is a typical example of the magnificent bedsteads which were made in England for Royal palaces and noblemen's houses in the latter part of the seventeenth century. Boughton House was rebuilt during that period by Ralph, Duke of Montagu, who was Ambassador to the Court of France at the time of Louis XIV. The decoration and furnishing of the house were completed by 1694, when William III. and his Court visited Boughton, and it was for this occasion that the bedstead is said to have been made.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

INDIAN SECTION COMMITTEE.

The following is the list of the Indian Section Committee, as appointed by the Council:—

Alan A. Campbell Swinton, F.R.S. (Chairman of the Council).
Sir William Duke, K.C.S.I., K.C.I.E. (Chairman of the Committee).
Lord Ampthill, G.C.S.I., G.C.I.E.
Sir Charles H. Armstrong.
Sir Arundel T. Arundel, K.C.S.I.
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Sir William Henry Clark, K.C.S.I., C.M.G.
Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.
William Coldstream, B.A., I.C.S. (retd.).
Laurence Currie, M.A., J.P.
Earl Curzon of Kedleston, P.C., K.G., G.C.S.I., G.C.I.E., D.C.L.
Right Hon. Sir Henry Mortimer Durand, G.C.M.G., K.C.S.I., K.C.I.E.
James Fairbairn Finlay, C.S.I.
Sir Frederic W. R. Fryer, K.C.S.I.
Colonel Arthur Hills Gleadowe-Newcomen, C.I.E., V.D.
Sir Krishna Govinda Gupta, K.C.S.I.
Colonel Sir Thomas Hungerford Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
Sir Philip Perceval Hutchins, K.C.S.I.
Lord Inchcape, G.C.M.G., K.C.S.I., K.C.I.E.
Lord Islington, P.C., G.C.M.G., D.S.O.
Sir Henry Evan M. James, K.C.I.E., C.S.I.
Sir John Jardine, Bt., K.C.I.E., M.P.
Louis James Kershaw, C.I.E.
Sir Henry Ledgard.
Sir Frederic S. P. Lely, K.C.I.E., C.S.I.
Sir Charles Campbell McLeod.
Colonel Sir Arthur Henry McMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I.
Sir John Ontario Miller, K.C.S.I.
Sir Prabashankar Dalpatram Pattani, K.C.I.E.
Right Hon. Sir Joseph West Ridgeway, G.C.B., G.C.M.G., K.C.S.I.
Sir Charles Montgomery Rivaz, K.C.S.I.
Sir Frederick Alexander Robertson, LL.D.
Colonel Sir Richard Carnac Temple, Bt., C.B., C.I.E.
Carmichael Thomas.
Sir James Thomson, K.C.S.I., M.A.
Sir James Wilson, K.C.S.I., M.A.
Colonel Charles Edward Yate, C.S.I., C.M.G., M.P.
S. Digby, C.I.E. (Secretary).

CHAIRMANSHIP OF THE COMMITTEE.

At the request of the Council, Sir Charles S. Bayley, G.C.I.E., K.C.S.I., will act as Chairman of the Indian Section Committee during the absence of Sir William Duke, K.C.S.I., K.C.I.E., who is accompanying the Right Hon. E. S. Montagu, M.P., to India.

CANTOR LECTURES.

The Cantor Lectures on "Civic Architecture and Town Planning," by Professor Beresford Pite, F.R.I.B.A., are being reprinted from the *Journal*, and the pamphlet (price one shilling) will shortly be obtainable on application to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.

A full list of the Cantor and Howard Lectures which have been published separately, and are still on sale, can also be obtained.

PROCEEDINGS OF THE SOCIETY.

THE EXAMINATIONS OF 1917.

In the able speech in which, last April, the Minister for Education enunciated the principles he has since embodied in his Bill for the reform of British education, he advocated the deliverance of the youthful student from the incubus of examinations. According to Mr. Fisher, there are now about a hundred examinations

available for young persons of examinable age.* How the number was arrived at is not stated. If Mr. Fisher included the professional examinations, Medicine, Law, Engineering, Architecture, Accountancy, Actuarial Business, Banking, etc., he might have remembered that candidates, as a rule, content themselves with a single profession, and enter only for the examination (or series of examinations) required for it. If he reckoned up the various examining bodies, he might have largely increased his total, for he might have remembered that nearly all such bodies hold not one examination, but a number of separate and independent examinations. That is obviously true of the Universities, and, to take only a single instance of other institutions, the City and Guilds Institute now hold eighty absolutely distinct and separate examinations in different subjects attracting different candidates.

But there cannot be much doubt that the real grievance which Mr. Fisher had in his mind was caused, not by the professional examinations to which he specially referred, but by the multiplicity of school-leaving or equivalent examinations which exist in this country. At the present time a schoolmaster may have in the same class boys preparing for Oxford and Cambridge Locals, Smalls, or Little-go, London and other modern University Matriculations, Civil Service and Professional Examinations, etc., all with different standards and different qualifications. The grievance is a real one, and to a certain extent irremediable, because there must always be a point when education begins to specialise. The special teaching has to be provided, but the method of its provision must be systematised, and this is what the Minister of Education has to do, and what, no doubt, Mr. Fisher will do to the best of his ability.

The professional bodies can look after their own examinations. They ought not themselves to test their candidates' general education, and if they can help it they do not want to. They should be, and for the most part are, content to accept evidence of this, if they can get it, and it ought to be provided, by means of suitable examinations, not necessarily official, but certainly recognised by official authority.

* "We hope also to deal with another grave defect in our present scheme of secondary school life. I allude to the great multiplicity of examinations. I am informed that there are no less than one hundred separate examinations for which boys in a secondary school may, at one time or another, desire to prepare. Every profession frames its own conditions of entrance without much regard to the general educational convenience of the country." Statement by Mr. Herbert Fisher, April 19th, 1917, in introducing Education Estimates

The difficulty has, of course, long been realised by the Board of Education, but it cannot be admitted that their method of dealing with it has met with general approval. Their main idea seems to have been to abolish all examinations, to abandon their own and to encourage the abandonment of all other general examination, leaving it to the institutions, schools and colleges to hold examinations for themselves. Their present policy is indeed a total reversal of all their earlier traditions.

The Board was formed by the union, in 1900, of the Education Department and the Department of Science and Art. Of these two bodies the former was concerned solely with Primary Education, the latter with Education in Science and Art. When it was first established, the Department of Science and Art was, so far as education was concerned, almost solely an examining body. It may, indeed, be said to have had but two functions, one to look after the South Kensington Museum, and the other to conduct examinations in Science and in Art. It was wholly independent of the Education Department, which was concerned entirely with elementary schools. Both of its duties it carried out with considerable success. The Museum soon took a high place among the art collections of the world, and the School of Science gradually collected to itself a brilliant staff of professors, ranking at least on an equality with the professorial staffs of our old universities. Its examinations developed to an enormous extent, but their quality hardly equalled their quantity. Truth to tell, the system of "payment by results" was well calculated to produce a marvellous growth, but the crop was not of high value. Still, the examinations did really good work by encouraging the growth of scientific education all over the country. Local science schools, beginning as classes for earning the Government grant, developed into colleges and universities, and it is to the "payment by result" system that all our flourishing modern universities owe their origin.

Such being, in briefest outline, the history of Government examinations in this country, and their results, is it to be wondered at that the recent tendency of the Department responsible for them to repudiate its own work should have met with a good deal of hostile criticism?

But it must be remembered that the criticism was directed against the action of the Board before its present head came into office, and there is no reason why Mr. Fisher should not

still make a judicious use of a properly devised system of school and general examinations. His criticisms affect only the multiplicity of examining bodies, and here they will have the full sympathy of all who have any real knowledge of examinations. There are doubtless a large number of institutions which are really doing over and over again the same examining work. But surely the best remedy for this would be for the Board of Education either to extend its own examinations, or to take over and develop any examinations held by independent institutions which are worth development. Probably all that would be required would be that they should adopt with suitable modifications and extensions the technical examinations of the City and Guilds Institute and the commercial examinations of this Society. To these might be added, perhaps, the Oxford and Cambridge Local Examinations, but probably these would be better left in the hands of the Universities while officially recognised by the Government. If they would do this, it is probable that other competing bodies would give up their examinations; and if they did not, the superior authority of the Government examinations would gradually supersede them.

The Society of Arts has made numerous efforts at some sort of unity or amalgamation. More than once the question of abandoning the Society's examinations has arisen, and in 1881 they were actually given up on the ground, as stated in a report of 1879, that the field was adequately covered by the Education Department, the Universities, the Science and Art Department, the City and Guilds Institute, and the College of Preceptors. But the abandonment of the Society's examinations aroused a very vigorous protest from the institutions affected, and the result was that they were resumed in 1882. Their enormous growth since that date shows their great popularity, and may be taken as evidence that they supply what the students demand. The Society has always carefully watched their development, and has been guided, in any changes which have been made, by the national demand. It is possible that the Society does not supply what advanced educational theorists may consider the best possible scheme of examination; but it certainly does supply what the students desire, and the present scheme is entirely a natural development guided by the demands, so far as they can be ascertained, of those who enter for the examinations.

That some such solution of the existing problem may eventually be adopted by the Minister of Education is suggested by the fact that he has recently appointed a committee or council to prepare a system of examinations for secondary schools.* It is understood that this may be looked upon as a revival of the 1914 scheme for the annual examination of grant-earning schools which was temporarily abandoned a year or so later because, in consequence of the war, the necessary funds could not be provided. Till more is known about the new system, any comment on it would be undesirable. But if a scheme at once comprehensive and liberal, not too rigid, and capable of modification to suit the needs of different localities, and different conditions of life, can be devised, it will be welcomed by all true friends of education.

In the meantime some consideration of the known views of the Board of Education on examinations is permissible. Not only does the Board oppose examinations generally, but they prefer that such examinations as are permitted should be of the kind known as internal, as opposed to external—that is to say, examinations conducted by the teaching staff instead of by outside bodies. Where, as in the case of Universities, there is an abundant supply of competent and qualified examiners, who are also teachers, the question does not arise. But the conditions are wholly different in the case of such examinations as those conducted, say, by the City and Guilds Institute, the Universities (in their local examinations), the College of Preceptors, and the Royal Society of Arts.

It may be well to state frankly the more important practical objections to the internal system of examinations. In the great majority of cases the teachers at the institutions from which the candidates are drawn are not specially qualified to conduct examinations. Then it is certain that the teachers themselves, as well as the students, are stimulated by the external examination, which is a valuable incentive and a useful guide as to the

* The announcement that such a council would be appointed was made in May last, and the notice of its appointment in September. As at present constituted, it includes representatives of the Oxford and Cambridge Schools Examination Board, the Oxford Delegacy and the Cambridge Syndicate for Local Examinations, the Universities of London, Durham and Bristol, the Northern Universities Joint Matriculation Board, the County Councils Association, the Association of Municipal Corporations, the Association of Education Committees, and the Teachers Registration Council.

direction of the teachers' work. Where examinations are held in different parts of the country by independent authorities, there is a lack of standardisation. The result of this is that they are regarded by employers as of slight value, and the certificates are consequently of little use to the candidates in one of their main objects—the obtaining of future employment. And in addition to these and other objections, there is one which in practice may be regarded as the most important of all, and that is that it is impossible to regard examinations by local institutions of their own students as trustworthy.

For many years the Society conducted its examinations through the agency of separate voluntary committees, and a vast majority of these committees were absolutely beyond suspicion. But, though it is painful to have to make the admission, in a minority of cases the committees could not be relied upon for the honest conduct of the examinations. As the importance of such examinations increased, and the competition between the various institutions grew keener, cases of absolute fraud became more numerous; and at last, in a case of more than usual dishonesty, the Society was compelled to take legal action, and a conviction was obtained. The inquiries instituted in connection with this action showed that the evil was widespread, and affected not only the Society's examinations. But the Society's object having been attained —that of showing that every possible effort would be made to maintain the high character and the scrupulous impartiality of its examinations—there was no object in going further into an extremely unpleasant investigation.

That any system of examination can be perfect is obviously impossible. But it is difficult to avoid the conclusion that, in their advocacy of internal examinations, the Board took an unpopular if not an unwise line; and this is shown by the well-known fact that although they were supported by some teachers and local authorities, the majority of those competent to form an opinion on the subject took an adverse view of the Board's action. The Board was no doubt largely influenced by their view that external examinations, and especially examinations in single subjects, acted as a deterrent to the full development of the "group system" of instruction, which for a few years before the war they were strongly advocating.

It may be added that in consequence of the Board's abolition of its higher Science examinations, applications have been made to the Society that it should institute Science examinations on the same lines as the old examinations of the Department of Science and Art, to replace those which have been abolished. The Council of the Society have not thought it wise to consider such applications favourably, and they think it improbable that under any circumstances the Society ought to undertake such a task. It is true that the machinery is already available, and it would not be impossible to apply to Science subjects the organisation now existing for the conduct of the Commercial examinations. But the feeling of the Council was that unless such a proposal was supported by very strong evidence from different parts of the country of its necessity, the Society certainly should not undertake the work; and further that if such evidence was forthcoming, it should be applied to induce the Board to reconsider its own action, and not to stimulate the formation of an entirely novel system in place of that which had been abandoned.

While the Board of Education has been trying to abolish examinations altogether, another department, the Civil Service Commission, has been endeavouring to improve the very important examinations under its control. For some time past a departmental committee, of which Mr. Stanley Leathes was chairman, has been considering the question, and they lately issued a very sensible report. They point out that the object of the examinations in question (those for Class I. of the Civil Service) is to secure the best men for the work, and they suggest certain changes in the character of the examinations, designed to test the general knowledge and capacity of the candidates. Another object of their recommendations is obviously—though not ostensibly—to foil the crammer in his insidious and constant fight with the examiner.

So long as there are examinations, with valuable posts as the reward of success, there will be people who prepare candidates for them, and a skilfully-prepared candidate will always get the better of a man of equal capacity who has not been taught to arrange his knowledge in such fashion that he can produce it readily in the form of answers to questions. When the number of possible questions is limited, and their character ascertainable beforehand by exhaustive analysis of previous examination papers, the crammer has the best of it. Indeed,

the candidate is helpless without his aid. The greatest master of the English language might fail miserably in an examination paper in English which any properly-prepared candidate for the Home or Indian Civil Service would regard with contempt.

The examiner, in undue terror of the crammer, by whom he has so often been worsted, is prone to take refuge in the uncrammable subjects, Mathematics, the Ancient Languages, etc. Then he is called upon to abandon his ancient fortresses, and to carry on the combat with his enemy on the level plain of utilitarian subjects, the subjects which are considered useful in daily life, and this he has got to do. So long as he has merely to test a candidate's knowledge of a subject, his task is easy enough. There is no difficulty in finding out whether a Frenchman has a thorough mastery of English, or an Englishman of French; whether a shorthand writer can take down 150 words a minute or only fifty; whether a typist can turn out an accurate transcript of an author's illegible manuscript, or merely copy without many blunders a paragraph of printed matter. It is when the competitive principle comes in that the examiner is driven to devices which subject him to the sway of the crammer; when he has to arrange, say, fifty candidates in a row, of which the first ten may get valuable prizes, the next twenty remunerative jobs, and the last twenty nothing, or less than nothing, since the humiliation of failure is certainly a minus quantity.

The question, however, of cramming and competition as affecting examinations does not immediately concern us now; but the general conclusions arrived at by the committee are of interest, because they recommend the application to examinations of a higher grade of precisely the principles which have always been followed by the Society in the organisation of examinations of a lower grade. For this reason the admirable State document of Mr. Stanley Leathes and his colleagues may be cordially commended to the notice of those who are interested in this department of the Society's work.

It is hardly necessary to say that the difficulty found last year in successfully carrying out the work of the examinations was accentuated this year. The staff had been reduced to the lowest possible dimensions, several of the examiners were occupied with war work, and others had lost the services of assistants who had previously helped them in their work. It is, therefore, satisfactory to be able to report that all the detailed work was regularly and punctually carried out. No doubt the diminution in the number of papers as compared with pre-war years was of some help, as it sensibly diminished the amount of work to be done.

As last year, the local educational authorities also had their own difficulties, caused by precautions against air raids, lighting regulations, diminution of railway facilities, and other like matters. These were met by authorising the holding of the examinations at earlier hours when necessary, due precautions being taken to preserve the secrecy of the papers of questions, and by otherwise relaxing the general regulations.

As stated in the last two reports, the finance of the examinations has been the cause of considerable anxiety. The object of the Council has always been to make the examinations pay their own expenses, and whenever there was a surplus of profit to employ it for the improvement and development of the system. It was stated in last year's report that for the ten years before the war there had been an annual profit of about £100 (no very large margin on an expenditure of over £4,000), and this justified the Council in incurring the increased cost of two examinations instead of one in 1914. But the war upset all the calculations. Instead of the anticipated increase, there was a diminution in the number of candidates, and the Society's Financial Statement of June 1915 showed a difference of £875 to the bad, and last year's a similar loss of £1,035. It was evident that the examinations could not be continued on these conditions, and the only way of increasing the revenue was to raise the candidates' fees.

The announcement was accordingly made that the fees for the two lower stages would be raised from 2*s.* and 2*s.* 6*d.* respectively to 2*s.* 6*d.* and 3*s.*, and the fee in the Advanced Stage from 2*s.* 6*d.* to 3*s.* 6*d.* It is satisfactory to be able to state that the change was accepted with hardly a single objection, and that it had certainly no effect in discouraging the entry of candidates, since the number of entries was practically the same as last year.

The financial result has also been quite satisfactory. The amount of the receipts shown in this year's Statement (June 1917) is £3,482, while the expenses are given as £3,262, a surplus of £220 instead of a loss of, say, £950 (£1,910 in two years). It is worth while to repeat the reminder that the Society's State-

ment published in June does not show the comparative annual cost of the examinations. The receipts are those of 1917, the expenses are mainly those of the examinations of 1916. It may, however, be taken that the result is that there is now no reason for further anxiety as to the cost of the examinations. With the higher scale of fees the examinations should pay for themselves, even if there is a considerable drop in the number of candidates, and there is no reason for anticipating such a drop. It seems much more probable that there will be an increase, though in times like the present any calculation as to future events is obviously quite hopeless.

Previous to 1880, when the examinations were free, the largest number of candidates in any year was a little over 2,000. This number was reached and surpassed in 1890. During the next ten years there was a steady annual increase, till in 1900 there were nearly 9,000. The effect of the Technical Instruction Act of 1889 sent the numbers up in 1901 to over 12,000. In the following year there was a trifling increase. In 1903 they passed 16,000; in 1904 they nearly reached 18,000; and in 1905 they exceeded 21,000. In the next three years there was a moderate increase up to 22,000; and in 1909 they shot up to more than 25,000. In two years more they passed 27,000; and in 1914, after a small decrease for two years, they reached their highest point, 29,000. In 1915, the first examinations after the beginning of the war, the number dropped to 23,260 and last year there was a further fall to 19,315. The number for the current year shows a nominal increase to 19,398, but may practically be regarded as the same as in 1916.

It may be interesting to note that during the present century nearly four hundred thousand candidates have been examined.

The total number of entries for this year's examinations was 26,185—10,411 for the March examinations and 15,774 for those in May. This included applications from 279 prisoners of war or interned men at Ruhleben, Groningen, Chateau d'Oex, and Mürren, at all which places special arrangements for examinations were made. The total shows a trifling increase on that of 1916, when there were 25,979 entries. It should be understood that these figures represent, not the number of individual candidates, but the number of papers applied for.

The number of candidates who came up for examination at centres in the United Kingdom was 19,398. These 19,398 candidates worked 24,221 papers—Advanced 2,625, Intermediate (including Theory of Music 128) 8,395, and Elementary 13,201.

The numbers of papers worked were divided between the two examinations as follows:—

	March.	May.	Total.
Advanced Stage	610	2,015	2,625
Intermediate Stage	2,560	5,835	8,395
Elementary Stage	6,591	6,610	13,201
	9,761	14,460	24,221

It will be seen, therefore, that the increase in the total number of candidates was due to the larger number entering for Stage I. There was an actual decrease in the numbers for the two higher stages, but this was counterbalanced by the considerable addition to the numbers for the Elementary Stage. This is clearly shown in the diagram on page 814, which gives the history of the three stages since the rearrangement of the system in 1905. It is based on the numbers of papers worked, which gives a slightly fairer basis of comparison than the number of candidates, though the results would be practically identical whichever number was adopted. Considering the figures before 1915, it will be seen that the line for the Advanced Stage shows a fairly regular ascent with a moderate increase of 1,000 (from 5,000 to 6,000). The Intermediate Stage, starting with double the number, 10,000, increases at a more rapid rate to 13,000, an increase of half as much again. The Elementary Stage, starting from an intermediate point, 8,500, and remaining near it for a year, rises with a rapid ascent to 16,000, nearly double its original numbers, passing Stage II. in 1910. In the first examination after the war began, 1915, we find a serious drop in all numbers, the relative proportions not being very different, the fall being lowest in Stage I. and highest in Stage III. In the following year there is a very heavy fall in Stage III., one of half the amount in Stage II., and quite a small one in Stage I. In the current year the two higher stages show very small decreases and the lowest stage a moderate increase.

The cause for these fluctuations is not difficult to perceive. The candidates in the higher stages are just of the age which is most

affected by the war, and they are carried off to war work of one sort or another—the young men to the army, the young women to fill the vacancies. The Elementary Stage candidates are mostly of school age.

Probably the full effect of the war was not felt until the second year, hence the drop in the two curves, while this year the conditions of 1916 have been fairly maintained, and the numbers for Stages II. and III. remained nearly the same, while there was a slight recovery in Stage I.

In addition to the 19,398 examined in the annual examinations there were 261 candidates in Colloquial Modern Languages. There were also 125 candidates from the Continental centres for interned men and prisoners. As there was some delay in getting back the worked papers, it was found more convenient not to include the returns in the general classification, but the details are given in another part of this report (page 808). The total number of candidates who were examined in all subjects by the Royal Society of Arts during the year ending July last, was, therefore, 19,784. Last year there were 19,695.

The results of the March examinations were sent to the centres concerned—the Advanced and the Intermediate Stages on June 7th, the Elementary Stage on June 19th. The results of the May examinations were issued—the Advanced Stage on July 12th, the Intermediate on July 31st, and the Elementary on August 21st. The complete list of all the results, classified under localities, was published this month.

Since the examinations were first started, medals and money prizes were awarded for the best papers in the various subjects. Last year financial considerations compelled the Council reluctantly to abandon the money prizes; but they were enabled, by the liberality of the Court of the Clothworkers' Company, to continue the offer of medals as usual. This year the same generous aid was provided, and the same course was adopted. For many years the Clothworkers' Company has presented the Society with the sum of £40 to be expended in prizes for certain specified subjects, and the Court very kindly acceded to a request from the Council that they would permit their grant to be applied generally for the purpose of providing medals in all the subjects, instead of special prizes in selected subjects.

The Society was therefore enabled this year to award 18 Silver and 31 Bronze Medals, the former in the Advanced Stage and the latter in the Intermediate.

The general results of this year's examinations are given in Table A (page 809), and a comparative view of the numbers in the higher stages for the last six years (1912–17) is given in Table B (page 810). Tables C and D (page 811) show the percentage of successes and failures in all subjects of the two higher stages for the present year; while the percentage of successes and failures in all stages for the past six years are to be found in Table E (page 811). Table F (page 811) gives the number of candidates, papers, and subjects in the Elementary Stage since 1905. Table G (page 811) shows the number of papers worked in all stages during the last twelve years. Tables H and I (page 812) show the percentage of failures in the different subjects of the two higher stages for the last six years. Table K (page 813) gives the numbers of candidates examined during the same period. In Table L (page 813) are shown the results of the Viva Voce Examinations held at various centres during the current year.

The diagram on page 814 gives the numbers of candidates in the three stages from 1905 to 1917, and shows graphically the changes in the stages.

The diagram on page 815 shows the progress of the examinations from 1900 to 1916. As the changes in numbers are this year so small, it has not been thought needful to carry on for 1917, as there is practically no change in the figures.

The commercial subjects included Book-keeping, Accounting, Banking, Shorthand, Typewriting, Economic History and Theory, Précis-writing, Theory and Practice of Commerce, Commercial Law, Company Law, Economic Geography, Arithmetic, Commercial Correspondence, etc., Handwriting, etc., English, French, German, Spanish and Italian. The other subject of examination was Music, divided into Rudiments of Music and Harmony.

Book-keeping is this year, as for many years past, the most popular subject. The number of papers, 6,951, is 264 above the 6,687 of last year, though this is still far below the numbers of pre-war years, which reached nearly twelve thousand. Of these, many more than half were in the Elementary Stage, the actual proportion being four-sevenths, while the Intermediate papers were three times as numerous as the Advanced. The examiner reports that on the whole the results were very much the same as last year.

The next most popular subject is, as usual, Shorthand. This shows a considerable increase (450) on last year, the numbers being 5,982 and 5,532. Here also the proportion of Stage I. papers is very large, a little more than a half belonging to this stage and rather less than that proportion to Stage II., and only a twelfth to Stage III. In Stage III. the percentage of first-class passes is very much higher than last year; the percentage of failures is also much larger, and the percentage of second-class papers a good deal lower. In Stage II. exactly opposite results were attained—the percentage of first-class being rather lower than last year, that of the second-class much higher, and the failures less. In the Elementary Stage the results were very similar to those of last year.

Typewriting, the next largest subject, does not attract half the number entering for Shorthand, and this year there is a falling-off in numbers of 190, there being 2,448 papers, and last year 2,638. But the falling-off, as compared with previous years, is not very serious, for the largest number examined in this subject was 2,806 in 1914. About three-fifths of the total were in Stage I., half the remainder in Stage II., and the rest, say one tenth, in Stage III. The examiner reports that the work on the whole was quite satisfactory—that in the Elementary Stage showing a decided improvement on last year.

In Arithmetic the numbers show a good advance on last year—there were 2,349, an increase of 123 over the 2,226 of 1916. This is the more satisfactory, because the two previous years both showed a large deficiency. The candidates were divided approximately among the three stages in the proportions of three-fourths to Stage I., under one-fifth to Stage II., and the balance, say rather more than a twentieth, to Stage III. On the whole the character of the work sent in was hardly up to the usual standard. As regards Stage III. the work of the best candidates was up to the standard, but that of a large proportion was, the examiner says, quite out-classed. In Stages I. and II. the percentage of failures was high, and the work on the whole not good.

The only other one of the commercial subjects which runs into four figures is Commercial Correspondence and Office Organisation. This subject has developed considerably of late years. For long it was confined to the Elementary Stage under the title of Handwriting and Correspondence. In 1911 a paper in Commercial Correspondence and Business Training was set in Stage II., and it is only this year that the subject has been admitted into the Advanced Stage. The total number of papers for the current year was 1,973. This shows an increase over last year of 126. Three-quarters of the papers were in Stage I., a sixth in Stage II., and a twelfth in Stage III.

English shows an increase of 75 over the 559 papers of 1916, the number this year being 634. As regards Stage III. the examiner considers that there is no appreciable difference in the general standard of the work submitted. In Stage II. this year's work is not quite so good on the whole. In Stage I. the improvement noticed last year has not been maintained.

The falling-off in the number of candidates for Economic Geography is deplorable. Two years ago there were 246 papers, last year there were 180, and this year there are only 98. The subject is one of great importance and high value, and it is a matter for extreme regret that more attention is not devoted to it at the various centres. Nor is the deficiency in quantity made up for by any improvement in quality. It has, however, to be remembered that the students of the more advanced subjects, of which Economic Geography is certainly one, are all of the age and class most affected by the war.

Last year in Economic History there were no candidates, at least there were not enough entries to justify the setting of a paper. This year there were 8, all of whom passed. In Economic Theory there were 66 candidates, an increase of 20 over the 46 of last year. The percentage of failures was rather larger than last year.

Précis-writing has recovered a little from the steady decline in numbers to which it has been subject for some years past—there were 198 candidates in 1914, 138 in 1915, 74 in 1916, and this year there were 85. The standard of the work sent in seems to have been about up to the usual average.

Commercial Law shows a marked increase, though the numbers are naturally small—65, or 8 more than in 1916, and Company Law shows a slight falling-off—41, or 8 less than the 49 of the previous year. The total number of entries in the two subjects was the same as last year—106. In 1915 there were 288, and in 1914, before the division of the subject into two, there were 308.

In Accounting there were 122 candidates this

year, and 163 last, a falling-off of 41; and in Banking there were 29, a falling-off of 20 on the 49 of last year. As regards both subjects, it may be said that the standard of the work did not differ greatly from that of previous years.

Theory and Practice of Commerce shows a little falling-off this year, as there were only 180 candidates against 226 last year, a deficiency of 46. The numbers last year were only a very few beyond those of the year before. There were a very small proportion of first-class in Stage III., but in Stage II. the work is reported as being on the whole not unsatisfactory.

Coming to the modern language subjects, French, as usual, shows many more candidates than those for all the other modern languages put together. The number in French is 2,041, a deficiency of 244 compared with the 2,285 of last year. There was a heavy falling-off of 500 in the previous year, which again was less by 170 than in 1915. The numbers now amount to less than two-thirds of the entries of seven years ago.

The next largest number of papers was in Russian, for which there were 266—an increase of 139 on the 127 of last year. Though Russian examinations have been carried on for many years past, it was only last year that any large number of candidates presented themselves, and the numbers this year are more than double. Seventeen entered for the Advanced Stage, and all but four passed; 78 for Stage II., and of them 28 failed; 171 for Stage I., and of these 64 failed.

As might have been expected, German shows a falling-off, though the proportion is less than in the two previous years—215 candidates entered, a deficiency of 55 on last year's numbers of 270.

There was a large increase in Spanish—227 against 149. This and Russian are the only two modern languages showing an advance. In Italian there was a falling-off of 8—this year 53, last year 61.

The remaining language subject is English for Foreigners. This was started last year, and 547 candidates entered. Less than half that number (260) entered this year. A considerable deficiency might reasonably have been expected, as probably most of the Belgian refugees, who formed the bulk of the candidates, obtained the certificates they required at the first examination. The falling-off, however, is rather larger than might have been anticipated, as naturally a considerable proportion of those who took one of the lower stages might have been expected to have tried for a higher certificate in the present year. To some extent this was obviously the case, as 79 entered for Stage III. as against 12 last year. But in Stage II. there were only 114 to compare with 289, and in Stage I. only 67 against 246.

As was the case last year, there were also oral examinations in French, German, Spanish, Russian, and English for Foreigners, all in the London district—except at Manchester, where a small number of candidates were examined in French. In all 261 candidates were examined, 12 in Manchester and the rest in London; of these 116 passed, 89 with distinction, and 56 failed. The numbers in the different languages were—French 209, German 17, Spanish 11, Russian 12, English 12. In former years there were also examinations in Portuguese and Italian, and at Liverpool, Birmingham and Bristol. In each subject there was, as might well have been expected, a considerable falling-off. Altogether there were 119 candidates fewer than last year.

The oral examinations were started in 1902, when 280 candidates were examined. The numbers rose to 681 in 1905; after that there was a small diminution, the numbers varying slightly year by year, and falling to 583 in 1911, then they increased again to 688 in 1913, and this was the highest point yet reached, as in 1914 there was a drop to 628. Table L (page 813) gives in detail the results of this year's examinations.

The oral examinations are held at any of the Society's centres where the necessary arrangements can be made, at any date convenient to the local committee. The examination includes dictation, reading, and conversation, and is so arranged as to test efficiency in colloquial knowledge of the language, without laying too much stress on minute grammatical accuracy.

The examinations in Rudiments of Music and Harmony were carried on as usual at the same time as the Commercial examinations, and the results appeared as part of the results of the Intermediate Stage.

In Rudiments of Music 78 candidates presented themselves; last year there were 110. In Harmony there were 50, as compared with 114. Of the 78 candidates in Rudiments of Music, 68 passed and 10 failed. Of the 50 candidates in Harmony, 35 passed and 15 failed.

The deficiency in numbers was not compen-

sated by any improvement in quality, for the examiner reports the results as being much the same as last year. There has been a continuous decrease in the number of candidates entering for these examinations during the past twenty years. In 1908 there were 716, and there has been a steady annual fall ever since. Whether under these circumstances it is worth while going on with the examinations will be a matter for consideration next year. They will of course be kept on in the 1918 examinations, and have their usual place in the programme.

The arrangements made last year for enabling prisoners of war and men interned abroad to get the benefit of the Society's examinations were repeated this year. Last year examinations were held at Ruhleben in Germany, and at Groningen in Holland. This year they were again held at these places, and centres were also formed in Switzerland at Mürren and at Chateau d'Oex. In all cases the arrangements were the same as last year. No fees were charged, and it was left for the local committees to arrange their own time-tables and to hold the examinations at any date convenient to themselves. Of course, the strictest precautions were taken to preserve the secrecy of the examination papers until the date for holding the regular examinations in this country had passed. The arrangements for the transmission of the papers were made with the help of the committee formed under the authority of the Board of Education for assisting prisoners.

At Ruhleben entries were received for both divisions of the examination, but unfortunately, the papers for the Second Division were stopped by the German Censor (though a promise had been made that they should be passed unopened) on the ground that they contained political references. This was unluckily true, for the examiner in précis-writing had selected for treatment "Correspondence with the United States Ambassador respecting the Treatment of British Prisoners of War in Germany." It must be frankly admitted that such a paper, however suitable for English candidates, ought not to have been sent to a prisoners' camp in Germany, and that the German Censor was quite justified in suppressing it. He might, however, have been contented with that, and not have seized the other papers, which were quite harmless. However, he laid his embargo on the lot, and the unhappy prisoners were deprived of the examination for which they had been preparing.

For the First Division, 57 papers were worked at Ruhleben. Of these, 31 were in Stage III., and all but one passed; 13 were in Stage II., with 9 passes and 4 failures; 13 also were in Stage I. and they all passed. The subjects taken up were Accounting, Book-keeping, French, Russian, and Spanish.

At Groningen examinations were held in both divisions of the examinations. 49 papers were worked—12 for the Advanced Stage (11 passes and 1 failure), 14 for the Intermediate (12 passes and 2 failures), and 23 for the Elementary (13 passes and 10 failures). The subjects were Arithmetic, Accounting, Book-keeping, French, and German.

At Chateau d'Oex 24 papers were worked in Book-keeping and Shorthand. Of these 8 were in Stage II. (6 passes and 2 failures) and 16 in Stage I. (11 passes and 5 failures).

At Mürren there were 5 candidates, 1 in Stage III. and 2 in Stage II., all of whom passed, and 2 in Stage I., both of whom failed. Both at Chateau d'Oex and at Mürren the Second Division only of the examination was taken.

The Examination Programme for 1918 was issued in September. In it will be found the fullest possible information about the examinations, a syllabus of each stage of each subject, and the papers set in May, 1917.* The attention of both teachers and students may be drawn once more not only to the syllabuses but also to the remarks of the various examiners on the results of last year. It will be found that these contain many valuable and helpful suggestions, and the work of the candidates year after year shows that far too little attention is paid to them. Teachers especially are earnestly recommended to study these remarks, as they ought to be guided by them in the instruction they give to their pupils.

The regulations for the Examinations in the Theory of Music, and those for the Viva Voce Examinations in Modern Languages, are also given at full length.

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* The price of the Programme for 1918 is 4*d.*, post free 6*d.* Copies can be obtained on application to the Secretary of the Royal Society of Arts, Adelphi, London, W.C. (2) Programmes containing the papers set from 1905 to 1916 can also be obtained (price 3*d.* each year, post free 4*d.*). The papers set in March, 1915, April, 1916, and March, 1917, are not included in the 1916, 1917, and 1918 Programmes. They are printed in separate pamphlets, price 2*d.* each (post free 3*d.*). The regulations and syllabuses for the present year can also be had separately (without the papers), price 1*d.*, by post 1½*d.*

TABLE A.—DETAILS OF THE 1917 EXAMINATIONS.

Subjects.	Stage III.—Advanced.				Stage II.—Intermediate and Music.							Stage I.—Elementary.			Total number of papers worked in all stages.
								Music Certificates.							
	Papers worked.	1st class certificates.	2nd class certificates.	Not passed.	Papers worked.	1st class certificates.	2nd class certificates.	Higher.	Inter-mediate.	Elemen-tary.	Not passed.	Papers worked.	Passed.	Not passed.	
Arithmetic	84	15	18	51	459	41	186	..	..	..	232	1,806	1,105	701	2,349
English	25	5	18	7	155	29	84	..	..	..	42	454	273	181	634
Book-keeping	743	104	338	301	2,247	290	1,302	..	..	..	655	3,961	2,380	1,581	6,951
Economic Geography	7	2	3	2	13	1	2	..	..	..	10	78	45	33	98
Shorthand	501	113	171	217	2,877	491	1,415	..	..	..	971	2,604	1,863	741	5,982
Typewriting	143	31	55	57	759	219	323	..	..	..	217	1,546	1,126	420	2,448
English for Foreigners	79	7	34	38	114	13	61	..	..	..	40	67	30	37	260
Economic History	5	3	2	..	3	3	..	..	..	..	..	..	..	..	8
Economic Theory	33	2	25	6	33	6	18	..	..	..	9	..	..	..	66
Précis-writing	24	5	12	7	61	11	43	..	..	..	7	..	..	..	85
Commercial Correspondence and Office Organisation	49	5	23	21	388	6	227	..	..	..	155	1,536	1,039	497	1,973
Commercial Law	65	2	25	38	..	..	..	..	..	..	..	..	..	..	65
Company Law	41	7	26	8	..	..	..	..	..	..	..	..	..	..	41
Accounting	122	26	57	39	..	..	..	..	..	..	..	..	..	..	122
Banking	29	4	13	12	..	..	..	..	..	..	..	..	..	..	29
Theory and Practice of Commerce	60	4	35	21	120	21	64	..	..	..	35	..	..	..	180
French	488	99	288	105	800	148	490	..	..	..	162	753	397	356	2,041
German	49	19	24	6	87	20	58	..	..	..	9	79	37	42	215
Italian	10	4	3	3	24	10	10	..	..	..	4	19	13	6	53
Spanish	51	15	28	8	49	13	25	..	..	..	11	127	92	35	227
Russian	17	3	10	4	78	7	43	..	..	..	28	171	107	64	266
Rudiments of Music	..	..	..	..	78	..	..	42	..	26	10	..	..	..	78
Harmony	..	..	..	..	50	..	..	7	18	10	15	..	..	..	50
Totals	2,625	475	1,203	951	8,395	1,329	4,351	49	18	36	2,612	13,201	8,507	4,694	24,221

Table B.—Number of Papers Worked in each Subject of Stages III. and II. in 1912-13-14-15-16-17.

Subjects.	1912. Stage III.—Advanced.	1912. Stage II.—Intermediate.	1912. Totals.	1913. Stage III.—Advanced.	1913. Stage II.—Intermediate.	1913. Totals.	1914. Stage III.—Advanced.	1914. Stage II.—Intermediate.	1914. Totals.	1915. Stage III.—Advanced.	1915. Stage II.—Intermediate.	1915. Totals.	1916. Stage III.—Advanced.	1916. Stage II.—Intermediate.	1916. Totals.	1917. Stage III.—Advanced.	1917. Stage II.—Intermediate.	1917. Totals.
Arithmetic	93	690	783	93	669	762	132	733	865	118	659	777	70	438	508	84	459	543
English	87	357	444	63	303	366	78	271	349	53	260	313	18	151	169	25	155	180
Book-keeping	2,156	4,127	6,283	2,179	4,118	6,297	2,469	4,295	6,764	1,690	3,267	4,957	879	2,209	3,088	743	2,247	2,990
Commercial History and Geography	24	60	84	19	44	63	13	41	54	..	..	..	..	..	..	..	..	..
Economic Geography	..	..	..	..	..	..	..	..	..	18	38	56	..	23	23	7	13	20
Shorthand	774	4,120	4,894	755	4,174	4,929	740	4,134	4,874	562	3,449	4,011	511	2,747	3,258	501	2,877	3,378
Typewriting	224	885	1,109	213	824	1,037	244	974	1,218	200	931	1,131	166	788	954	143	759	902
English for Foreigners	..	..	..	..	..	..	..	..	..	..	..	..	12	289	291	79	114	193
Economics	59	91	150	55	110	165	64	94	158	..	..	..	..	..	..	..	..	..
Economic History	..	..	..	..	..	..	..	..	..	14	10	24	..	..	..	5	3	8
Economic Theory	..	..	..	..	..	..	..	..	..	47	56	103	18	28	46	33	33	66
Précis-writing	72	144	216	63	98	161	66	132	198	58	80	138	18	56	74	24	61	85
Theory and Practice of Commerce	..	..	..	..	..	..	76	78	154	83	150	233	64	162	226	60	120	180
Commercial Correspondence and Business Training	..	454	454	..	603	603	..	583	583	..	606	606	..	463	463	49	388	437
Commercial Law	380	..	380	297	..	297	308	..	308	184	..	184	57	..	57	65	..	65
Company Law	..	..	..	..	..	..	..	..	..	104	..	104	49	..	49	41	..	41
Accounting and Banking	476	..	476	490	..	490	488	..	488	..	..	..	..	..	..	..	..	..
Accounting	..	..	..	..	..	..	..	..	..	384	..	384	163	..	163	122	..	122
Banking	..	..	..	..	..	..	..	..	..	125	..	125	49	..	49	29	..	29
French	793	1,497	2,290	756	1,293	2,049	793	1,181	1,974	756	1,063	1,819	591	853	1,444	488	800	1,288
German	224	332	556	197	303	500	188	280	468	109	176	285	70	117	187	49	87	136
Italian	20	12	32	17	22	39	23	33	51	13	20	33	20	21	41	10	24	34
Spanish	73	97	170	72	86	158	117	92	209	74	76	150	42	51	93	51	49	100
Portuguese	14	10	24	13	15	28	20	9	29	..	..	..	..	..	..	..	..	..
Russian	2	8	10	3	8	11	8	9	17	..	..	..	..	24	24	17	78	95
Danish and Norwegian	6	6	12	5	5	10	3	4	7	..	..	..	..	..	..	..	..	..
Hindustani	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..
Swedish	6	..	6	3	3	6	..	4	4	..	..	..	..	..	..	..	..	..
Japanese	..	5	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chinese	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Arabic	..	..	..	..	7	7	..	3	3	..	..	..	..	..	..	..	..	..
Dutch	..	..	..	..	..	..	2	6	8	..	..	..	..	..	..	..	..	..
Totals	5,483	12,895	18,378	5,293	12,685	17,978	5,832	12,957	18,789	4,592	10,841	15,433	2,797	8,420	11,217	2,625	8,267	10,892

Table C.

Percentages of Successes and Failures, Advanced Stage, 1917.

	First-class.	Second-class.	Failures.
Arithmetic	17·85	21·43	60·72
English	20·00	52·00	28·00
Book-keeping	13·94	45·71	40·35
Economic Geography	28·57	42·86	28·57
Shorthand	22·56	34·13	43·31
Typewriting	21·68	38·46	39·86
English for Foreigners	8·86	43·04	48·10
Economic History	60·00	40·00	0·00
Economic Theory	6·05	75·75	18·20
Précis-writing	20·83	50·00	29·17
Commercial Correspondence and Office Organisation	10·00	47·00	43·00
Commercial Law	3·08	38·46	58·46
Company Law	17·08	63·41	19·51
Accounting	20·80	48·00	31·20
Banking	13·79	44·83	41·38
Theory and Practice of Commerce	6·66	58·34	35·00
French	20·12	58·54	21·34
German	38·77	48·98	12·25
Italian	40·00	30·00	30·00
Spanish	29·40	54·90	15·70
Russian	17·65	58·82	23·53

Table D.

Percentages of Successes and Failures, Intermediate Stage, 1917.

	First-class.	Second-class.	Failures.
Arithmetic	8·93	40·52	50·55
English	18·71	54·19	27·10
Book-keeping	12·90	57·89	29·21
Economic Geography	7·70	15·30	77·00
Shorthand	17·07	49·18	33·75
Typewriting	28·86	42·55	28·59
English for Foreigners	11·40	53·52	35·08
Economic History	100·00	0·00	0·00
Economic Theory	18·18	54·54	27·28
Précis-writing	18·04	70·49	11·47
Commercial Correspondence and Office Organisation	1·55	58·50	39·95
Theory and Practice of Commerce	17·50	53·33	29·17
French	18·50	61·25	20·25
German	22·99	66·67	10·34
Italian	41 67	41·67	16·66
Spanish	26·53	51·02	22·45
Russian	8·97	55·13	35·90

Table E.

Percentages of Successes and Failures in all Stages, 1912–13–14–15–16–17.

Advanced (Stage III.).

	1912.	1913.	1914.	1915.	1916.	1917.
First-class	11·42	14·70	13·92	15·57	16·88	18·07
Second-class	47·09	58·17	50·19	52·44	53·98	45·76
Failures	41·49	27·13	35·89	31·99	29·14	36·17
Intermediate (Stage II.).						
First-class	15·27	10·88	15·13	19·92	18·31	16·09
Second-class	55·91	58·18	52·79	51·12	52·10	52·63
Failures	28·82	30·94	32·08	28·96	29·59	31·28
Elementary (Stage I.).						
Passes	64·99	61·08	63·46	66·28	62·84	64·44
Failures	35·01	38·92	36·54	33·72	37·16	35·56

Table F.

Elementary Examinations, Stage I. 1905 to 1917.

Year.	No. of candidates.	No. of papers worked.	No. of subjects.
1905	7,397	8,427	10
1906	7,425	8,537	10
1907	7,692	8,952	10
1908	8,276	9,811	10
1909	9,196	11,069	10
1910	10,289	12,720	10
1911	11,277	14,286	10
1912	11,448	14,936	10
1913	11,096	14,611	10
1914	12,104	16,046	11
1915	10,000	13,584	11
1916	9,297	12,555	13
1917	9,859	13,201	13

Table G.

Number of Papers Worked in all Stages, 1905 to 1917.

	Stage III.	Stage II.	Stage I.	Total.
1905	4,844	10,533	8,427	23,804
1906	4,904	10,734	8,537	24,175
1907	4,815	10,802	8,952	24,569
1908	4,795	11,199	9,811	25,805
1909	5,433	12,512	11,069	29,014
1910	5,309	12,843	12,720	30,872
1911	5,931	14,025	14,286	34,242
1912	5,483	13,583	14,936	34,002
1913	5,293	13,302	14,611	33,206
1914	5,832	13,544	16,046	35,422
1915	4,592	11,350	13,584	29,526
1916	2,797	8,650	12,555	24,002
1917	2,625	8,395	13,201	24,221

The numbers for Stage II. include the papers set in Music.

TABLE H.

PERCENTAGES OF FAILURES IN ALL SUBJECTS, ADVANCED STAGE, 1912-13-14-15-16-17.

	1912.	1913.	1914.	1915.	1916.	1917.
Arithmetic	50·52	50·53	58·00	40·68	50·00	60·72
English	48·27	41·27	32·05	33·96	27·78	28·00
Book-keeping	49·12	26·48	36·45	37·10	40·96	40·35
Commercial History and Geography	37·50	21·05	46·15	..	..	..
Economic Geography	..	..	..	38·90	..	28·57
Shorthand	60·73	25·30	63·11	39·50	23·68	43·31
Typewriting	32·59	27·70	34·43	33·50	13·85	39·86
English for Foreigners	..	..	..	..	50·00	48·10
Economics	25·42	14·54	18·75	..	..	..
Economic History	..	..	..	14·50	..	0·00
Economic Theory	..	..	..	19·00	11·12	18·20
Précis-writing	29·17	26·98	30·30	34·48	5·55	29·17
Commercial Correspondence, etc.	..	..	..	..	..	43·00
Commercial Law	35·00	38·38	35·39	38·04	28·07	58·46
Company Law	..	..	..	31·73	36·73	19·51
Accounting and Banking	28·56	27·35	27·26	..	..	..
Accounting	..	..	..	22·91	28·22	31·20
Banking	..	..	..	25·60	34·70	41·38
Theory and Practice of Commerce	..	..	34·20	36·15	20·31	35·00
French	22·07	19·84	18·66	18·91	21·66	21·34
German	31·25	41·12	28·19	20·18	11·43	12·25
Italian	10·00	11·77	13·05	23·11	30·00	30·00
Spanish	23·30	33·34	22·22	35·14	23·82	15·70
Portuguese	14·29	7·72	10·00	..	..	..
Russian	0·00	0·00	0·00	..	..	23·53
Hindustani	..	..	..	..	..	..
Danish and Norwegian	0·00	0·00	0·00	..	..	..
Swedish	50·00	33·34	0·00	..	..	..
Dutch	..	..	100·00	..	..	..

TABLE I.

PERCENTAGES OF FAILURES IN ALL SUBJECTS, INTERMEDIATE STAGE, 1912-13-14-15-16-17.

	1912.	1913.	1914.	1915.	1916.	1917.
Arithmetic	29·71	27·95	28·78	28·98	41·78	50·55
English	28·57	36·30	21·77	29·62	23·18	27·10
Book-keeping	33·44	26·52	25·28	25·86	25·53	29·21
Commercial History and Geography	26·66	27·27	34·15		..	..
Economic Geography	..	..	..	34·21	52·17	77·00
Shorthand	23·18	40·10	45·50	36·42	36·88	33·75
Typewriting	34·01	25·97	33·58	21·59	23·98	28·59
English for Foreigners	..	..	..	..	14·18	35·08
Economics	15·38	15·45	16·00	..	..	..
Economic History	..	..	..	10·00	..	0·00
Economic Theory	..	..	..	7·14	17·86	27·28
Précis-writing	25·70	22·45	25·76	30·00	5·35	11·47
Theory and Practice of Commerce	..	..	29·50	47·34	39·51	29·17
Commercial Correspondence and Business Training	34·36	31·67	21·27	31·02	35·64	39·95
French	25·05	18·64	20·32	18·53	20·76	20·25
German	39·76	42·90	33·22	30·68	17·10	10·84
Italian	16·67	22·73	21·22	20·00	38·00	16·66
Spanish	28·86	23·26	32·61	19·74	21·56	22·45
Portuguese	60·00	40·00	55·56	..	..	..
Russian	37·50	0·00	22·23	..	8·32	35·90
Danish and Norwegian	33·33	20·00	0·00	..	..	..
Swedish	..	66·66	50·00	..	..	..
Japanese	60·00	..	..	..	..	..
Hindustani	..	..	100·00	..	..	..
Chinese	..	..	..	..	..	..
Arabic	..	42·86	0·00	..	..	..
Dutch	..	..	33·34	..	..	..

TABLE K.

CANDIDATES EXAMINED IN 1912-13-14-15-16-17.

	1912.	1913.	1914.	1915.	1916.	1917.
Commercial Knowledge—						
Stage III.—Advanced	4,754	4,618	5,065	3,715	2,624	2,277
Stage II.—Intermediate (including Theory of Music)	11,855	11,580	11,873	9,554	7,394	7,262
Stage I.—Elementary	11,448	11,096	12,104	10,000	9,297	9,859
Totals	28,057	27,294	29,042	23,269	19,315	19,398
Music (Practice)	296	273	244	—	—	—
Colloquial Modern Languages	633	688	628	453	380	261
Army Candidates (1912-13-14) and Prisoners of War, etc. (1917)	45	54	57	—	—	125
Totals in all Subjects	29,031	28,309	29,971	23,722	19,695	19,784

TABLE L.

VIVA VOCE EXAMINATIONS HELD DURING 1917.

Centre of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French:—	1917.				
Acton and Chiswick Polytechnic	May 9	28	8	11	9
Enfield Technical Institute	May 8	41	2	29	10
Manchester Education Committee	May 24	12	3	6	3
Pitman's School	May 23	19	11	5	3
,, ,,	May 24	17	9	4	4
City of London College	May 25	25	6	10	9
Kensington College	June 5	29	10	15	4
Regent Street Polytechnic (Candidates from London Institutions)	June 8	19	7	7	5
St. Clement Danes' School (Candidates from L.C.C. Institutes)	June 26	19	8	6	5
German:—					
City of London College (Candidates from London Institutions).	June 25	17	10	5	2
Spanish:—					
St. Clement Danes' School (Candidates from London Institutions)	June 27	11	2	9	..
Russian:—					
City of London College (Candidates from London Institutions).	June 18	12	2	8	2
English for Foreigners:—					
St. Clement Danes' School (Candidates from L.C.C. Institutes)	June 28	12	11	1	..
Totals		261	89	116	56

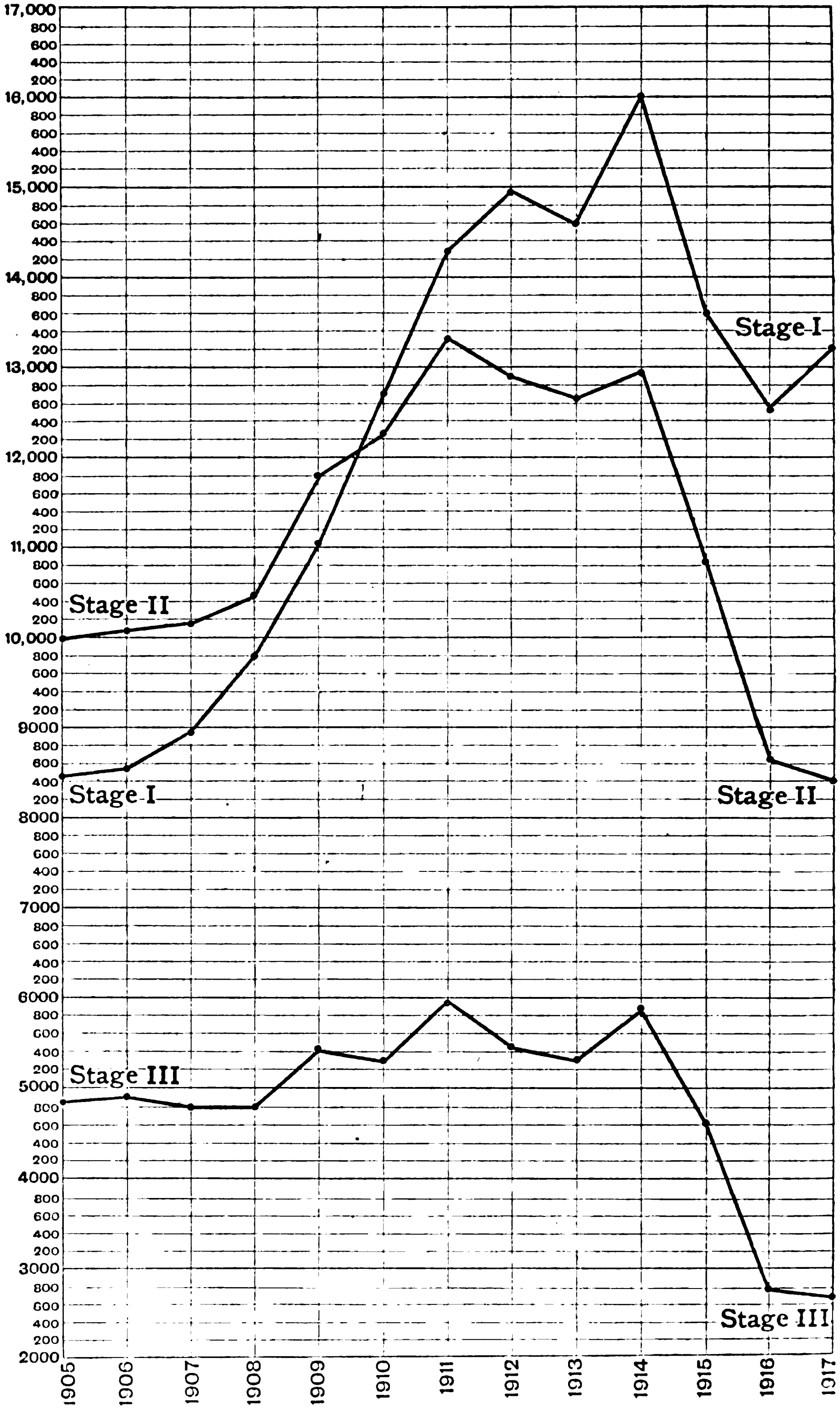

DIAGRAM SHOWING THE NUMBERS IN THE THREE STAGES, 1905-1917.—
I. ELEMENTARY; II. INTERMEDIATE; III. ADVANCED.

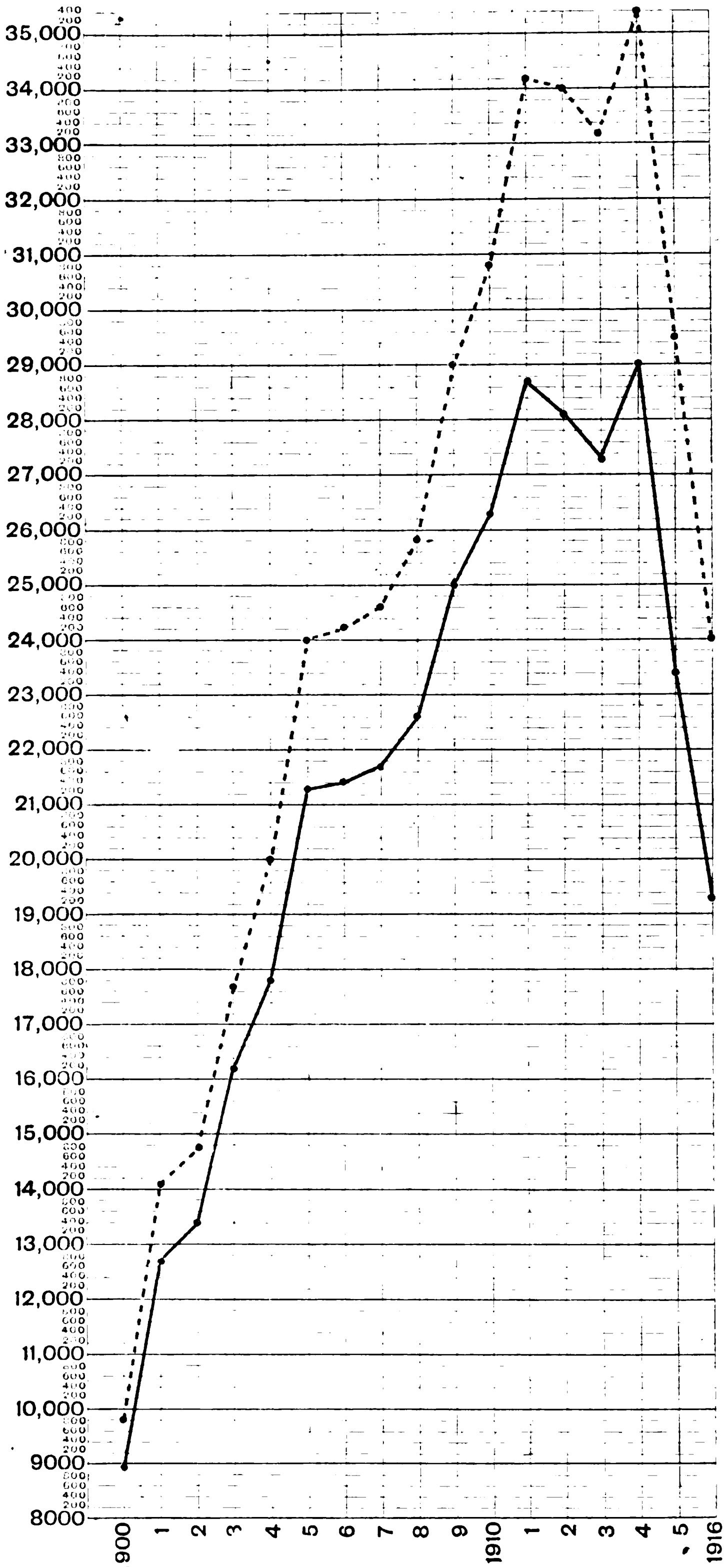

Diagram Showing Progress of Examinations, 1900–1916.

The solid line shows the number of candidates, the dotted line the number of papers worked.

NOTES ON BOOKS.

THE PRESS AND PRINTERS OF JAMAICA PRIOR TO 1820. By Frank Cundall.

This latest contribution of the accomplished secretary of the Institute of Jamaica to the early history of the Colony shows the same painstaking and exhaustive care that marked his previous writings. It is in the form of a reprint of a paper communicated to the American Antiquarian Society in 1916, and is published by the Society at Worcester, Mass.

The history covers a period of just a century, for the earliest record of the existence of a printing-press in Jamaica is dated 1721, when an order was given for the printing of the votes of the House of Assembly. On somewhat uncertain authority it is stated that a weekly paper, the *Jamaica Courant*, was started in 1722, and if this is correct it antedates the *Barbados Gazette* of 1731, usually considered to be the earliest of West Indian newspapers. The oldest existing specimen of Jamaica printing is an almanac of 1734, preserved in the library of the Institute of Jamaica.

The *Jamaica Gazette* is said to have been started in 1745. Such are the beginnings. For a long time there seems little to chronicle except pamphlets and official publications; and, indeed, down to the end of the period to which Mr. Cundall has limited himself (1820), there does not seem much of literary interest or value to record. A few books were printed and published in the island, but most of the literary work produced by Jamaicans, or dealing with Jamaica, was naturally enough published in England. Mr. Cundall has, however, found material enough for a historical narrative of over sixty large octavo pages, which contains a great deal of detailed information interesting to the student either of the history of the Colony, or of the history of the art.

About as much more space is occupied by two appendixes. The first of these is bibliographical, and deals with newspapers, street almanacs, book almanacs, magazines, and books. The second gives a full account of Jamaican printers.

GENERAL NOTES.

SUPPLIES OF SEED WHEAT.—The Food Production Department is offering farmers a special selection of seed wheat of the varieties known as Wilhelmina, Little Joss, Victor, and Browick. The seed has been selected and cleaned with great care, and the percentage of purity is in no case less than 99. The selection was undertaken by a special committee under the direction of Professor Biffen. Standing crops were inspected by these experts in all the English wheat-growing districts in order that only crops of outstanding quality might be chosen for the Department's seed wheat orders. The price of this selected seed is 90s. per quarter of 480 lbs. f.o.r., including new non-returnable sacks. Parcels of the seed wheat are stored at a number of centres throughout England, and the Department will endeavour to supply the seed from the district indicated by the purchaser on his order form. Supplies of these seed wheats will be ordered forward by the Food Production Department immediately on receipt of an order made out on the official form, and accompanied by a cheque for the requisite amount, provided that supplies are still available. Should the purchaser desire to have a sample of the wheat the Department will send one, but this must necessarily involve some delay in the delivery of the seed.

PROSPEROUS COOLIES.—The prosperity of the Federated Malay States in the past year is reflected in the annual report of Mr. C. H. Allin, Director of Posts and Telegraphs. The Post Office Savings Bank had 8,227 depositors, an increase of 669 over the previous year, and the total amount on deposit was $654,771, which is equal to £76,390. As this amount represents a portion of the savings of the Indian and Chinese labouring classes, it must be considered as highly satisfactory, in view of the additional fact that large amounts are transmitted by the banks and the Post Office to relatives in India, Ceylon, China and elsewhere. No less than 77,902 postal orders, 152,681 money orders, and 5,576 telegraphic money orders were issued, all showing considerable increases on the previous year, the total amount transmitted being £705,316. —*Colonial Journal.*

EXPORT OF INDIAN HIDES TO GERMANY. Some remarkable figures in connection with this pre-war trade are quoted in *Empire Trade Notes*. From 1911 to 1913 the normal export of Indian cow-hides to Hamburg and Bremen was about 3½ millions per annum, but in the first six months of 1914 the figures to these two ports were over 2½ millions. In addition to this, Austria used to take normally nearly 1½ million cow-hides through Trieste, and in the first six months of 1914 took over 1,178,000. In three and a half years before the war these enemy ports together took from India nearly 19½ millions of cow-hides.

PAPER SHORTAGE IN NEW ZEALAND.—There has been a great shortage of printing paper in New Zealand during the past year, though the imports in 1916 were greater in quantity than those of 1914. The imports from the United Kingdom, says the *Paper Maker*, increased from 85,534 cwt. in 1915 to 96,551 cwt. in 1916, while those from Canada declined from 260,739 cwt. to 213,524 cwt. The shortage has been chiefly felt in newsprint. Imports of writing paper were very much larger than in 1915; imports from the United States alone increased from £1,459 to £20,789. The United States has taken the chief place in the supply of butter paper and also of materials for cardboard box-making, the imports of which showed an increase.

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FRIDAY, NOVEMBER 2, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

COLONIAL SECTION COMMITTEE.

The following is the list of the Colonial Section Committee, as appointed by the Council:—

Alan A. Campbell Swinton, F.R.S. (Chairman of the Council).
Lord Blyth (Chairman of the Committee).
Marquess of Aberdeen and Temair, P.C., K.T., G.C.M.G., G.C.V.O.
Octavius C. Beale.
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Hon. Frederick W. Young, LL.B., Agent-General for South Australia.
S. Digby, C.I.E. (Secretary).

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

MEMORIALS AND MONUMENTS.

By Lawrence Weaver, F.S.A.

Lecture I.—Delivered March 5th, 1917.

The spirit of the subject which I am putting before you to-day, that of "Memorials and Monuments," is best seen, I think, in these words from the book of Ecclesiasticus, which many schools and colleges sing as an anthem on their Commemoration Day, when they remember their pious founders and benefactors:—

"Let us now praise famous men and our fathers that begat us. The Lord hath wrought great glory by them through His great power from the beginning. There be of them that have left a name behind them, that their praises might be reported. And some there be which have no memorial; who are perished as though they had never been."

And then the writer of Ecclesiasticus returns to those who have been honoured in remembrance, and he goes on:—

"Their name shall remain for ever, and their glory shall not be blotted out. Their bodies are buried in peace, but their name liveth for evermore. The people will tell of their wisdom, and the congregation shall shew forth their praise."

We shall indeed have failed in our honourable duty if posterity can say of our gallant soldiers and sailors, "Some there be which have no memorial; who are perished as though they had never been."

The art of war memorial design (and it is mainly of war memorials that we are all thinking) has precisely this intent—worthily to show forth the praise of those who have given up their lives for our safety and honour. The author

of the first book on monuments—a man, oddly enough, of my own name—writing as long ago as 1631, gave this simple but entirely adequate definition :—

"A monument is a thing erected, made, or written for a memorial of some remarkable action yet to be transferred to future posterities."

When the war is over we shall have many pressing duties of national and social and of military and economic reconstruction; but there will be one duty, or rather privilege, which must not be overlooked—the setting up of fitting monuments. Nor is it likely to be overlooked, for our hearts will be filled with a passionate gratitude; but we must see to it that this gratitude takes shapes worthy of the occasion, worthy of the country, and worthy of British art. In this connection I would remind you that an organisation called the Civic Arts Association has lately been established. It has many purposes. The wide scope of its title indicates that it is concerned to raise the level of civic art at large, but its more immediate and practical purpose is to educate public taste in the matter of war memorials, whether they are simple tablets to humble individuals or noble monuments to great regiments and to large groups of men, such as the heroes of a village or city, or the old boys of a public school. Still greater than these will be the national monuments to the men of the Imperial races. No doubt there will be set up, probably in London, a noble memorial to the Englishmen who have given their lives for merry England. Probably also Scotsmen, Irishmen, Welshmen, Canadians, South Africans, Australians, New Zealanders, and the Indian races will commemorate in imperishable marble and bronze the amazing gallantry of their brothers.

Before discussing questions of design, there is an initial matter to be faced: Should a memorial cause what the Philistines call a waste of money on useless art, or should the memory of brave deeds be enshrined in something utilitarian? There are always two parties in this discussion. In the case of a public school, for example, one will be anxious to fill some gap in the school equipment by founding scholarships or dedicating a new building. The other will be desirous of concentrating all effort on some striking monument which shall speak of heroic sacrifice to the generations following. I feel that the memorial of utility is best adapted to mark occasions of domestic interest in a school or university, such as a jubilee or centenary or the reign of a great "head," but we shall be commemorating something larger and more moving than anything that has gone before—a warfare not only of men and arms, but of spiritual ideas—a war to which the men of the Empire have brought more than thew and muscle, skill and wealth. The true intention of our war memorials will not be that of the old *memento mori*, but to give a vision of lives finely lived, in which death was only a final and compelling incident. The monuments of to-morrow will bear witness, to generations yet unborn, of a knightliness, a wealth of sacrifice, and a hardiness never before equalled even by the men who fought under Drake and Nelson, Marlborough and Wellington. For due memorial of these great spiritual forces we may well demand monuments like Miltonic poems, of a rich yet austere beauty which will express pride and gratitude as well as sorrow. Because we are a nation devoted to compromise, many institutions such as colleges and military units such as regiments will probably divide their efforts between monuments of beauty and monuments of utility, and, provided that means are large enough to ensure that the former shall be of adequate beauty, this will be the wisest course. It is to be hoped that schemes of a purely utilitarian sort will be excluded from consideration. Some such followed the South African War, but it would be bathos for a great school to commemorate this conflict of the nations by a new swimming bath or larger playing fields. Perhaps the ideal memorial is a building in which usefulness and monumental dignity are equally represented—a building where may be set some jewel of the sculptor's art, in which are concentrated all our emotions of pride and sorrow.

I have said so much by way of general introduction to my subject lest I be accused of indifference to the feeling that the greatest of all our memorials will be successful efforts to relieve the sufferings occasioned by the war, and to make this kingdom and Empire a happier place for those who will come after us.

My main purpose, however, is to discuss the artistic forms which may be taken by memorial monuments pure and simple. All monuments are the expression of an emotion, and our first means of expression is by the spoken and written word. It follows that the first element to be considered is the inscription, which sets forth the name, the personal qualities, and the services of the man or group of men to be commemorated. Many a monument has been made banal for lack of giving proper thought to the

matter and the manner of the inscription. In the seventeenth and eighteenth centuries dignity of expression often degenerated into sheer bombast, but that is hardly the danger now. We are rather afraid of showing our emotion. There is a good deal to be said for Dr. Johnson's attitude when he defended an exaggerated note in epitaphs by reminding their writers that in "lapidary inscriptions a man is not upon his oath." The inscription in Westminster to Richard le Neve, who "signaliz'd his valour to admiration in that sharp engagement with the Hollanders which happened on the 11th August, 1673," is a good example of written praise. A Crimean monument at Scutari for which Lord Macaulay wrote an inscription, is a good example of terse simplicity: "To the memory of the British Soldiers and Sailors who, during the years 1854 and 1855, died far from their country in defence of the liberties of Europe, this Monument is erected, by the gratitude of Queen Victoria and her people, 1857." It may be hoped that the anger and bitterness which we justly feel at the outrageous disregard of the rules of war shown by our enemies will not be perpetuated in our memorial inscriptions. A living example of the charity and humanity which may mark a memorial to the dead who were once our enemies is to be found in a monument at Chatham to the memory of French prisoners who died there during the Napoleonic Wars :—

Here are gathered together
The remains of many brave soldiers and sailors
Who, having once been the foes, afterwards the captives of England,
Now find rest in her soil,
Remembering no more the animosities of war
Or the sorrows of imprisonment.
They were deprived of the consolation of closing their eyes
Amongst the countrymen they loved,
But they have been laid in an honourable grave
By a nation which knows how to respect valour
And to sympathise with misfortune.

It is only when conflict between brave nations can leave an aftermath of tenderness and admiration such as this epitaph indicates that healing Time can bring together old enemies into so intimate a friendship and mutual trust as now bind together French and Russians with ourselves. With such names as Wittenberg and Ruhleben burnt into the tablets of our remembrance it is difficult to see how such an epitaph as that at Chatham can ever grace German graves in England—more's the pity!

I do not think that it is only friendship and pride in my old school which makes me think that Sir Henry Newbolt's inscription on the South African memorial at Clifton College is one of the most moving written in our day :—

Clifton, remember these thy sons who fell
Fighting far over sea,
For they in a dark hour remembered well
Their warfare learned of thee.

As a nation, we are now very shy of expressing religious feeling, but when the subject makes it fitting nothing can be finer than the simple statement of service rendered to the King of kings as well as to our ruler and nation. Could anything be more direct and appropriate than the lines which commemorate General Gordon in the memorial chapel at Khartoum Cathedral :—

Praise God for
Charles George Gordon,
A servant of Jesus Christ,
Whose labour was not in vain in the Lord.

I think that in personal memorials more use might be made of lines from our poets and prose writers. For the monument shortly to be set up to the memory of a true-hearted Guardsman who lately fell in France, I was privileged to draft the inscription, and as a pendant to the record of his name and services added Sir Francis Palgrave's lines :—

Who died as firm as Sparta's king
Because his soul was great.

The memorial at Manchester to Francis Thompson makes admirable use of his own lines, "Whatso looks lovelily," etc. I rather deprecate the expression of the sense of loss of those who remain by the use of such expressions as "In affectionate memory of," and other phrases made too familiar by the monument mason. Especially in the case of those who have fallen in war, the memory of the dead is not merely a family possession but a national glory. The highest function of a monument, even of the simplest tablet, is to stir those who come after to the emulation of noble deeds, and the appeal should be wider and less personal than is implied in phrases which speak merely of personal loss. The matter of inscriptions appears thus early in the series of lectures because its importance cannot be exaggerated, and because the form of the modern memorial, and especially of the regimental and other group memorials of the great war, will be decided in some degree by the vast number of names which will be graven on them.

I now come to some sketch of the development of memorial design as the history of English art

reveals it; and let me say at once that it is a very difficult byway of our archæology, and so far almost wholly untracked. When I set out to write my recent book, "Memorials and Monuments," my first and obvious task was to give something by way of an historical introduction which would trace the growth of different types and conventional treatments, both architectural and sculptural. It was soon evident that the literature of the subject was scrappy and disjointed and comprised little more than records of certain types, such as brasses, recumbent effigies, canopied tombs, and the like. I therefore endeavoured to prepare some credible sketch of the development of a few outstanding types, but recognise that I have only scratched the surface of what is almost virgin soil for the student of æsthetic forms and conventions. I will take, for example, the most convenient form of memorial, the wall tablet. We have been accustomed to accept this as an inevitable type, but its growth obviously has a history. The earliest English example I can find is the tablet to Sir Godfrey Foljambe and his lady, set up about 1383 in Bakewell Church. It consists of two half figures set in a canopied frame adorned above with two coats of arms. This developed, I think, for purely practical reasons, from the table tomb surmounted by a pair of full-length effigies. The churches were probably getting crowded with large monuments to pious benefactors, and the clergy resented any more floor space being occupied. To place the memorial on the wall was the only solution. There was also a mediæval type of floor slab in which only half the figure was sculptured, leaving the lower end of the slab plain. If this were set on end it would suggest the form taken by the Foljambe memorial. Another origin was probably the desire to provide a suitable frame for engraved brasses which had to be fixed to the wall for lack of suitable floor space. The tablet to Thomas Darcy at Maldon shows an elaborate late Gothic frame of stonework in which were once set some small brasses which have since disappeared. At Great Bardfield, in Essex, there is also a very late Gothic tablet to a man who died in 1584, and it was work of this kind which led the way to the typical Elizabethan and later tablets of which so many hundreds remain. Other types of wall tablet, particularly those in which a great heraldic achievement is the principal ornament, perhaps derive from an accessory of table tombs. It was not always convenient to carve these achievements on the tomb itself, and the heraldic ornaments and inscription were therefore placed on a vertical tablet fixed at one end of the table tomb, and lending itself quite naturally to treatment as a separate memorial. An example of this kind is to be seen at Saffron Walden on the tomb of Lord Chancellor Audeley. If we except memorials of the Foljambe type, which cannot be regarded as typical owing to their rarity, all English monuments derive directly from the slab level with the floor or the classical sarcophagus, which developed into the Gothic table tomb with or without effigies and canopies—arched canopies in the case of wall tombs, or complete independent canopies in the case of free-standing tombs. In Italy church architecture did not lend itself so readily to table tombs, which can in a Gothic church be so conveniently disposed between its many pillars. The wall tomb, sometimes in several stories and with very elaborate canopies, was therefore the more common form.

With such elaborate development of the wall tomb, it was natural that the wall tablet should show a notable growth and variety. The roundel with the bust of Brunelleschi, carved by Buggiane and set up about 1445 in the Duomo, Florence, and the more scholarly memorial of the same great architect by the same sculptor, now preserved in the Museo di Santa Maria, Florence, may be compared with Benedetto da Majano's memorial to Onofrio Vanni sculptured about the end of the fifteenth century, to show what a wealth of different treatments Italian artists applied to the wall memorial long before we did in this country. The tablet with the Medici arms, designed by Brunelleschi for the Abbey at Fresole about 1466, is an example of the exquisite art expended on a simple inscription at a time when we were unfamiliar with this type of thing.

Another interesting bypath of conventional design is the curtain motif. In many English Renaissance wall tablets, such as George Stepney's memorial in Westminster Abbey, there is a more or less defined treatment of curtains like the canopy of an old-fashioned bedstead. In Stepney's monument these curtains are very short and overhang the bust—a treatment derived at a long remove from a thirteenth-century Italian example. In Cardinal Braya's tomb in St. Peter's, Rome, sculptured not long after 1282 by Arnolfo di Cambio, the cardinal's effigy lies on a sarcophagus and two angels draw aside the curtains. Recumbent sleeping figures are themselves not much earlier in date. I have not been able to trace one earlier than that of

Cardinal Bernardo Caracciolo (in the Lateran), which is of 1255.

Another memorial convention, that of the kneeling figure, is not found in England during mediæval times. Even in Spain, where it has its most magnificent expression in royal tombs and on great retablos, as at the Cartuja at Miraflores, in Burgos Cathedral, in the figure of Juan di Padilla now in the Burgos Museum, and in the Capilla Real at Granada, the work though Gothic in detail is very late and rich, and was soon superseded by Renaissance treatment. The praying figure itself, as we see it in the Elizabethan monument probably derives from the quite small figures of pious donors represented in wall tablets such as are found about 1400 at Tournai Cathedral. Here the person commemorated was originally a comparatively trivial accessory to the main subject of the monument—for example, a large figure of the Virgin and Child. The tendency apparently was steadily to increase the size of the donor's figure and to make the devotional subject less important, until the latter was omitted altogether.

The mediæval architects and their successors in the sixteenth and seventeenth centuries were evidently conscious of the importance of placing a memorial rightly, so that it might become an organic element in the building; but there are some notable examples to the contrary. The cenotaph to Chaucer in Westminster Abbey was an old tomb taken from some other church, and set up in the Abbey in 1556 by one Nicholas Brigham. He did not hesitate to cut away the arcading in the south transept, to take this second-hand tribute of his regard for the Father of English poetry. Eighteenth-century architects made haste to copy this bad example, with the painful results to be seen, not only at Westminster, but in many another Gothic church. For all that, it is to be hoped that the Purists who want to clear away later memorials because they happen to be clumsy in themselves and to accord ill with their surroundings, will not be allowed to satisfy their sense of taste at the expense of æsthetic history. How greatly a memorial beautiful in itself may be ennobled by a right setting is nowhere better to be seen than in the crypt of St. Paul's. Immediately under the cross of Wren's dome, encased in a marble sarcophagus made by Rovezzano for the body of Cardinal Wolsey, but never used for that purpose, lies Lord Nelson. The tomb is ringed about by the circle of pillars which support the floor of the cathedral nave, and seem by their strength to represent with singular fitness the character of that great upholder of British sea-power. Even in the placing of the simplest tablet there is room for great care and judgment. It should have definite references to the architectural treatment of the wall. A lot has been made of the so-called ruining of church interiors by the multiplication of tablets, and this fear is very present now. It is true that churches like Bath Abbey suffer from an excess of memorials so marked that there is scarcely a square foot of wall space unoccupied. But it is also true that, with a few notable exceptions, the Bath memorials are lacking in any interesting quality of design or personal appeal. They mainly commemorate a vast number of highly respectable persons who sought the pleasant social atmosphere of Bath after lives spent on Colonial soil, and the catalogue of their virtues makes tedious reading. If, however, these memorials had the intrinsic beauty of, say, the group of heraldic tablets on the wall of the National Museum at Florence, I doubt if there would be any complaint of over-crowding.

When the builders of bygone days set about the work of putting up a memorial they had little regard for the work of their predecessors. We need to remember that the advent of Renaissance ideas in England brought with it a vast contempt for Gothic forms. Everything that lacked the classic impress was regarded as barbarous, and met with short shrift when alterations or additions to a building were afoot. But some sculptors of the seventeenth and eighteenth centuries must have had moments of compunction, as, for instance, Wren, who was great enough to study, and to admire, the skill of his Gothic forerunners. Nicholas Stone, who worked much with Inigo Jones, respected the Gothic arcading of Westminster Abbey, and made his memorial to Isaac Casaubon fit into one bay of it very neatly. A fine example of the just placing of a memorial on the outside of a building is at the Hospital, Corsham, typical of many another in its effective use of heraldry.

The lecturer then showed a series of slides illustrating the development of the simpler types of English memorial and the changes in artistic expression, and commented on the qualities of each. The subjects were as follows—the slides being taken from the illustrations of the lecturer's recent book, "Memorials and Monuments," by courtesy of its publishers:—

Tomb of Henry III., Westminster Abbey. By Peter the Roman. About 1280. Frankly Italian

work, which took no root in England despite its introduction by the King's favour. Bronze effigy by Willian Torel, goldsmith of London. c. 1291.

Tomb of Lady Margaret Beaufort, Westminster Abbey. c. 1511. By Torregiano and English craftsmen. First touch of the Renaissance in English memorial design.

Shakespeare Memorial in Stratford-on-Avon Church. Typical Jacobean wall memorial. By Gerard Jansen. c. 1616.

Sutton tomb, London Charterhouse. 1614. Nicholas Stone, sculptor; Bernard Jansen, architect. Stone continued working until 1647. The date of the Casaubon memorial is 1634.

Tablet to Sir John Lawrence, Chelsea Old Church. 1638. Delicate Italian detail unusual at that date.

Tomb of Lady Cheyne, Chelsea Old Church. c. 1671. Made in Rome. Architect, Paolo Bernini (son of Lorenzo). Sculptor, Antonio Raggi. First Baroque monument in England.

Tablet to John Gurdon, Assington Church. 1671. Typical English country work; simple frame moulding.

The Temple Memorial, Westminster Abbey. 1679.

Memorial to Thomas Mansell and William Morgan, Westminster Abbey. 1684.

Tablets to the Holders (1697) and Jane Wren (1702) in St. Paul's Cathedral crypt. Latter by Francis Bud.

Tablet to Viscount Teviot, Westminster Abbey. 1710. Military emblems.

Wall cenotaph of Katherine Bovey, Westminster Abbey. 1727. Designed by James Gibbs.

Groups of tombs in Painswick Churchyard of table type and various taller shapes. 1658-1798. Some carved by John Bryan, who lived 1716-1787, but varying much in character between great refinement and a marked coarseness of detail.

Brass to Mary Togerthwaite, with engraved heart, Middleham Church, Yorkshire. 1734. Typical country work.

Edward Montagu's tablet, Westminster Abbey cloisters. Of Coade stone; design in the Adam manner. 1787.

Weddell monument, Ripon Cathedral. c. 1793. Sculptor, Nollekens; architect unknown (? James Wyatt or Nicholas Revett).

Monument to John Volpato, Church of the Apostles, Rome. Canova, 1807.

Monument to Duke of Dorset, Withyham Church. Flaxman, 1815.

Monument to Duchess of Dorset, Withyham Church. Chantry, 1825.

Duke of Wellington, St. Paul's Cathedral. Alfred Stevens, 1858-73. Equestrian statue, completed by John Tweed, 1911.

Fawcett Memorial, Westminster Abbey. Alfred Gilbert, 1886.

WOOL UNDER CONTROL.

Three main purposes are implicit in the exceptional measures taken for the control of wool under war conditions. By declaration of contraband and the licensing of exports the supply of wool or woollens directly, or indirectly, to the enemy has been largely frustrated. By the State purchase of the British and principal Colonial supplies of wool, control has been established over the prices of the commodity, and this power has been strengthened and extended by fixed charges for the manufacture of the very large proportions of the whole that is required for the execution of military contracts. Purchase has given control also over the purposes to which wool shall be put; the present and, to some extent, the prospective requirements of the Allied Governments being met before material is released for civil home or export business.

In their turn all three of the main endeavours have given rise to some friction. The licensing of exports, however simple in theory, does not translate itself into practice without involving individuals in uncertainty and inconvenience. Experience, consultations, and the issue of notices in advance have gone far, however, to render individual troubles endurable. State purchase at arbitrary prices has raised questions of the adequacy of the price paid, but the spirit of compromise has come to the rescue, and prices about as far above pre-war rates as below those which might theoretically be obtainable in the market have removed gross discontent. The existence of the excess profits duty has done as much as anything to reconcile manufacturers to a scale of payment for work done, based upon costs instead of upon the strength of demand for manufacturing facilities. The margin allowed to manufacturers for contract work enables them at least to live, although it is far below that currently obtainable upon work for the civil market. It would seem that in respect of prevention of supply to the enemy, and the manufacture of indispensable goods for the Forces, a basis has been reached which will give continuous satisfaction as long as the war lasts. Patriotic promptings and a general sense of justness go hand in hand, and there is no anticipation that small readjustments cannot be made as occasion requires.

The State, however, cannot consume for military purposes all the kinds of wool that it has bought, and there is a surplus for resale

at what are apparently high profits; the Dominion Governments participating equally in any profits accruing upon wools bought from them. This profit-making is for the time being accepted as a necessary incident of the situation, but it cannot be said that either wool-growers or manufacturers approve of the principle which gives the surplus value of their commodity to the State, or that they would willingly allow that arrangement to outlast the war. The wool is surplus to the requirements for State services, and in the minds of traders a sharp distinction is drawn between wool and woollens necessary to win the war and the fair game out of which producers and manufacturers have been wont to make their livings.

The worst feeling that has been engendered by State control has arisen directly out of this distinction between military and private business, and from symptoms of a disposition to interfere arbitrarily with the latter. When the war ends there will end with it the huge consumption of wool for soldiers' clothes and blankets, and for ammunition cloths. Virtually all requirements will be transferred into civil ones, but the State will remain in possession of substantially the whole Imperial wool clip, and the great organisation that has been built up for the purchase and manipulation of the wool supplies will remain in being. The official declarations thus far made do not suggest an intention immediately to demobilise the departments controlling necessary materials. It is proposed that articles like wool, of which there is a total shortage, and which make demands upon shipping, shall rest subject to official control for an unspecified length of time to secure that industry shall be kept going and to avert panic prices.

The continuance of some form of control may be unavoidable for other reasons. The industries of other nations are dependent upon British supplies of wool, and claims may be received for *pro rata* treatment from them. A control over imports and exports and a check upon prices is apparently the least that would serve and the most that is necessary. The elaborate and expensive organisation built up for maximising the production and minimising the cost of cloths made to a few standard patterns is without justification for the permanent purposes of peace and its dismantling is solely a question of time. The demobilisation can hardly come too quickly to satisfy trade opinion, and once the war is over the difficulties of exerting a detailed control must be immeasurably intensified.

Upon a very superficial view all centralisation of control, all increasing of output, standardising of patterns and elimination of intermediaries, is beneficial to the industry concerned. Yet it is indisputable that the effects of war and the State intervention that war has entailed have largely been retrograde. Under the stress of circumstances raw material has been sacrificed for meaner purposes than those to which it would usually be put. Instead of being manufactured with a view to the development of all the good features of which the material is capable, wool has been roughly manipulated to produce a standard cloth which is not for regular purposes a marketable one. An industry conspicuous for the variety of its products has been limited to grinding out an extraordinarily few, without play for the exercise of its full abilities. Doubtless something has been learned from the experience, but it is erroneous to suppose that these are the lines upon which industry can be made most remunerative to those who take part in it.

The art of manufacturing, consisting in making the most of one's material and in producing special and varied goods, has unquestionably suffered a set-back. Greater cheapness may be arrived at by standardisation upon a larger scale, but not necessarily better profits, for competition is made more direct. Individual genius given play finds means of employing to advantage forms of material that other men reject, and of introducing goods that command a market by their novelty. A demand that absorbs every material that can be twisted to its purpose, and a control that does not take account of the varying value that one and the same raw material has to different consumers, is very unfriendly to the resuscitation of industry in its more advanced forms.

The higher and more successful development of manufacture is by no means secured by making concerns larger, linking undertakings together, and by simplifying processes in the interests of output without regard to the niceties of the finished result. The policy of lumping businesses together receives plenty of public encouragement, and it is represented to be a peculiarly necessary one, in face of the situation remaining at the end of the war. The State is palpably disposed to encourage as a principle the closer combination of manufacturers and the more general standardisation

of goods; but such developments can hardly be forced upon manufacturers. Economy is not consulted in pressing production beyond certain limits, and many concerns are as large as a thorough efficiency requires. The desirability of combining or of changing methods of manufacture and sale is a matter more for individual than collective judgment, and any general conclusions which might be formed in respect of more rudimentary trades are of less force in the case of an industry as highly specialised and advanced as that in woollen and worsted. Thus, any control that the State might care to attempt in the reorganisation of the industry must necessarily leave room for free will.

The fair success that has attended the arbitrary fixing of prices under war conditions cannot be looked for when the strain is over and the fervour of patriotic sacrifice is lost. From a certain moral altitude it doubtless appears that all public service is equal, and independent of peace or war; but this plane has certainly not been attained by traders. Had the case been otherwise, an arbitrary scale would still be impracticable, except in a moment of emergency. Wool is an international article of commerce, a commodity which in one sphere is competitive with all alternative forms of agricultural produce; and in another, with all the textile fibres that can be used in its stead. In order that wool may find its right place in the general economy, and that its production and use may be encouraged to the full, it is essential that the material should be allowed to find its own level of price, and that producers and consumers should be given the benefit of price movements.

It is fairly certain that for years to come the price of wool must be high. In normal times the whole annual production is consumed within the year, and it must take several seasons to replace the large deficiency of civilian goods. If the price tends to be prohibitive, the manifold influences for economising its use will come automatically into play to settle the values of wool in all its various forms. The trade accommodates itself to the conditions by producing mixed cloths, light-weight goods and fabrics, made from the class of wool that is relatively most abundant, and therefore cheap. Left to its own devices the industry finds its own ways of adjusting its products to the popular purse and popular taste, by dint of an ingenuity far greater than has been exercised in making Army goods from materials and upon machines not always directly suitable for the purpose. It would be illusory to picture wool textile production as it has hitherto been as perfect in its adaptation of means to ends; but a clear contradiction can be seen between the ideal of a production which, by its diversity, aims at pleasing all tastes, and that which would compel all comers, from want of choice, to accept goods forced upon the market by their sheer bulk. Two distinct conceptions of manufacturing are involved, and it may be felt that the one which takes the more account of the varying capacity of materials is the higher and the more valuable, although currently there is a strong tendency to disregard it and to think of success in manufacture rather in terms of quantity than quality.

FUEL RESEARCH.

The Fuel Research Board of the Department of Scientific and Industrial Research have issued a report, signed by Sir George Beilby, the Director of Fuel Research, describing the scheme of research they have adopted and their plan for the establishment of a fuel research station on an industrial scale.

In a previous report, which has not been published, they stated that they had in view two main lines of research: (1) A survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, and (2) an investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal by processes of carbonisation and gasification.

At one time it was thought that the former line of inquiry could be proceeded with in advance of the second, but further consideration has shown them to be so interdependent that they can be most satisfactorily dealt with side by side. However, in preparation for the organisation of the first line of inquiry, an experimental study of standard methods for the examination of coal in the laboratory has been made, and as the result of work carried out for the Board in the Fuel Laboratory of the Imperial College of Science a test has been elaborated which, by direct weighing and measurement, gives the yields of gas, oil, water, and carbonaceous residue that result from carbonisation at any definite temperature.

As regards the collection and registration of samples from different coal-mining districts, the representatives of the coalowners have shown every disposition to co-operate; but it is not proposed to start any extensive organisation for this purpose until the preparations for the second line of

inquiry are further advanced, since the accumulation of large numbers of samples would serve no useful purpose at present, and would be decidedly inconvenient.

The report then proceeds to summarise the fundamental problems of carbonisation, and the lines on which these problems are to be solved. Their solution will supply a new base from which to attack such questions as the following:—

(1) Can the 35 to 40 million tons of raw coal used every year for domestic heating be replaced wholly or partially by smokeless fuel, solid or gaseous, prepared by the carbonisation of this coal?

(2) Can adequate supplies of fuel oil for the Navy be obtained by carbonising the coal at present used in its raw form for industrial and domestic purposes?

(3) Can supplies of town gas be obtained more economically and conveniently by methods of carbonisation and gasification other than those now used in gasworks?

(4) Can electric power be obtained more cheaply if the coal used for steam-raising is first subjected to processes of carbonisation and gasification?

(5) Will the more scientific development of the preparation and use of fuel, which would be implied in the successful working out of the foregoing questions, enable the peat deposits of the United Kingdom to take a serious place as economic sources of fuel for industrial purposes?

(6) Can the use of gaseous fuel in industrial operations be forwarded by the development of more scientific methods of combustion in the furnaces, muffles, and ovens used in metallurgical, ceramic, and chemical operations?

Answers to these questions, the report points out, will be obtained only by co-ordinated research carried out on the lines of a broad and well-considered scheme; but at the same time the Fuel Research Board think it is to be expected that solutions of some of the problems will be supplied by workers in the industries, and they would regard it as a great misfortune were the establishment of a Government organisation for fuel research to result in discouraging or in any way limiting the activities of outside workers or organisations.

Disposal of Products.

Even if an efficient method of low-temperature carbonisation is evolved it will be valueless in the wider sense unless profitable outlets for all the important products can be developed; and the Fuel Research Board, being in official touch with the Admiralty, the Ministry of Munitions, the Board of Trade, and other public Departments, is exceptionally well placed for the furtherance of schemes that entail the finding of large outlets for products new and old. For instance, since the Admiralty attach great importance to the development of supplies of fuel oil from home sources, this requirement alone would absorb all the oil which could be produced by the carbonisation of tens of millions of tons per annum. This fact alone gives an entirely new aspect to the extension of carbonisation in hitherto untried directions, but while it will undoubtedly help on the economic side of the problem it does not relieve the pressure on the technical side. In a way, moreover, it accentuates the problem of the profitable disposal of the coke which is left when the volatile products have been distilled off the coal. On the average it may be taken that each ton of coal carbonised will give 15 cwt. of coke; hence, from the 20 million tons of coal which would have to be carbonised in order to obtain one million tons of fuel oil for the Navy, 15 million tons of coke would be produced.

The disposal of this large quantity of coke at a profitable price must be regarded as the vital question if low-temperature carbonisation is to be established on a sound economic basis. The research scheme must therefore include a very complete inquiry on the use and value of this coke for the direct firing of steam boilers, its gasification in producers for the manufacture of low-grade fuel gas, and the recovery of its nitrogen as ammonia, and its use for industrial and domestic heating, either directly as it comes from the retorts or after conversion into briquettes. The second of these inquiries will involve the development of a special form of gas producer and auxiliary plant if the best results are to be obtained, and also of a system of boiler firing in which fuel gas of low calorific value can be burned at least as efficiently as coal. The use of the lower grades of fuel gas, though successfully carried out in certain directions, is very imperfectly understood in the majority of industries in which gas might be used for heating and power.

Research Station.

It was realised that the conditions required for the research station could be fulfilled only by a site in the neighbourhood of a large gasworks. Some months ago the Director of Fuel Research approached Dr. Charles Carpenter, the chairman of the South Metropolitan Gas Company, and subsequently Dr. Carpenter, on behalf of the directors of his company, made the following very generous offer:—

(1) To lease the Government at a peppercorn rent sufficient land at the East Greenwich Gasworks for the erection of the research station.

(2) To prepare drawings and specifications for the station on lines laid down by the Board and to make contracts for its erection; and

(3) To give every facility for the transport of coal and other supplies to the station and to take over at market prices the surplus products, gas, tar, liquor, and coke, resulting from the operations of the station.

The site consists of a strip of level ground, about 250 ft. wide by 700 ft. to 800 ft. long, situated on the main siding which connects the gasworks with the South-Eastern Railway and possessing access to an existing road. The station, as planned,

will be capable of any extensions required for future researches. Of the four acres to be leased, only one acre will be occupied by buildings under the present scheme. Further, a large part of the equipment of the buildings will be of a permanent character and will serve all the general purposes of a research station. Future extensions, therefore, will not repeat this permanent equipment, but will be based upon it.

THE PEA-NUT INDUSTRY OF SOUTH INDIA.

The pea-nut, or ground-nut (*Arachis hypogea*), although grown in places all over India as a garden and even an occasional field crop, is produced on a commercial scale only in the Madras and Bombay Presidencies, in Burma, and in that part of French India (Pondicherry) that adjoins Madras. Cultivation in Bombay may be said to be confined to the Deccan and the Karnatik, with Sholapur and Satara, lying just north of the Madras Presidency, as the most important districts.

According to the latest official figures for the 1915–16 pea-nut crop, the total area in British India was 1,935,000 acres, as compared with 2,413,000 acres in 1914–15, and the total yield for 1915–16 was 1,011,000 tons of nuts in shell, as against 947,000 tons for the preceding year. The area in the Madras Presidency was 1,441,000 acres, and the yield 633,000 tons; in the Bombay Presidency, 232,000 acres with a yield of 275,000 tons; and in Burma, 262,000 acres and 103,000 tons.

Exports from ports in the Madras Presidency amounted to 115,200 tons in 1914–15, and 151,236 tons in 1915–16, the principal ports of shipment in the latter year being Madras, Cuddalore, Negapatam, and Porto Novo. Four-fifths of the total exports were consigned to Marseilles, the remainder going mainly to Calcutta, Burma, the Straits Settlements and Ceylon. Practically all the exports to Europe are of hulled seed.

It appears from a report by the United States Consul at Madras that, in addition to the amount exported from the ports in the Presidency, a large quantity of the product grown in the Madras area is shipped from the French seaport Pondicherry, 150 miles south of Madras on the Coromandel Coast. The industry in India is said to owe its origin partly to this French Colony, which apparently began to cultivate the pea-nut on a large commercial scale at the suggestion of soap manufacturers in Marseilles. As the Pondicherry settlement is small in area, 113 miles in all, the output of pea-nuts is not considerable in comparison with the adjoining British Provinces, part of whose crop thus finds a ready market close at hand.

At first Pondicherry was practically the only port in India that exported pea-nuts, but now Madras, Bombay, and the other ports mentioned rival it in importance. Madras has lately greatly increased its share of the traffic as the result of its improved railway connections with producing districts in the Deccan, and by reason of the facilities provided by the Port Trust of Madras for the storage and drying of the product in harbour warehouses, and for quick and cheap handling between sheds and steamers. Exports from Pondicherry in 1915–16 amounted to 42,238 tons—475,000 bags (of 166 lb.) of kernels and 94,000 bags of pea-nuts in the husk.

The pea-nut crop is now a profitable one in the Madras Presidency, but it has gone through precarious times as the result of the use of inferior seed by the cultivators, the deterioration of the crop by too frequent use of the land with consequent exhaustion of the soil, the attacks of fungoid disease or pests, the irregularity in the water supply, and finally, although not the least important from the commercial side, the deleterious methods in preparing the kernels for the market. The agricultural authorities and commercial interests have been endeavouring to effect improvements, and a good deal of progress has no doubt been made in some directions. As regards the quality and outturn of the crop, officers of the Department of Agriculture, after investigating various methods of cultivation, have published the results with recommendations for the farmers.

The Indian pea-nut originally was grown as an edible nut, but the great importance of the crop in South India now is due entirely to the growth of the seed-crushing industry both locally and abroad, and all efforts to improve the stock are with the view of increasing its oil-yielding property. The pea-nut now chiefly grown in the Presidency is known as the "Mauritius" variety.

A United States consular report, published in April, 1894, gave the percentage of the oil in the several varieties of peanuts grown in different parts of the world as follows: Senegal, 51; East Africa, 49; America, 42; and Madras, 43. In 1914 a report published by the Madras Department of Agriculture stated that the so-called Mauritius nut, grown as a rain-fed crop on the Government farm at Palur, Madras Presidency, yielded 49·84 per cent. of oil of good quality, and that with ordinary careful cultivation this standard could generally be maintained wherever local conditions were suitable for pea-nut growing. Local Mauritius is especially favoured because of the high percentage of kernel it possesses. The Department, however, is experimenting with thirteen different varieties, and some of them, especially a Barbados variety and a West African, are said to be promising. For over a period of three years the West African nut on unirrigated land has given an average yield of 505 lb. of

oil per acre, but on irrigated land the Mauritius variety is still ahead with an average of 950 lb., West African coming next with 877 lb. In case of need, or if the authorities consider that improvements will be effected thereby, the seed found to be the most suitable will be distributed to the farmers. Meanwhile, the farmers are being assisted generally with advice and supervision of methods upon request.

The Mauritius variety of pea-nut grown in Madras takes from five to six months to come to maturity. The best soil is said to be ash-coloured, absorptive, and fairly retentive of moisture. The nut, however, is most generally grown on the more prevalent red sandy loams; but the opinion prevails that the darker the soil the darker the nut and the less desirable for seed purposes. In India, it is stated, experience has shown that a light-coloured soil gives a light-coloured pod and thus improves the selling value as an article of food, although equally sound and well-flavoured nuts may be produced on other soils. Salt soils are unsuited, although stony soils rich in sand, if well manured, may yield a highly profitable return, while clayey soils are quite unsuited. In South Arcot the pea-nut displaced indigo, as it was more profitable. In the majority of cases in South Arcot the crop is sown in a standing crop of cumbu, ragi, or other cereal, when the latter is being hand-hoed. In places where the crop has been recently introduced and plenty of good manure is available, it is cultivated year after year on the same land, or only with an intervening crop at intervals of four or five years, while in some villages of the Shiyali taluk district it is cultivated without intermission. In the neighbourhood of Panruti the crop is changed once in four or five years. The most popular rotation of the pea-nut crop is with the cereal "varagu."

Seasons of sowing and reaping of the crop vary with the district, and depend on whether it is grown on dry or irrigated lands. Some districts get light rains during the south-west monsoon, but expect their season rain in October-December during the north-east monsoon. In this case sowing is done at the end of July or beginning of August. In other districts showers are experienced in April and May, while the season's rains occur with the south-west monsoon from June to September; in this case sowing is done as soon as a sowing rain falls in April or May. During the first two or three months of the crop's growth very little moisture is required; the plant can withstand considerable drought until it starts to flower and form its nuts. Pea-nuts as a dry irrigated crop are now extensively grown in the South Arcot district during the hot weather months, and cultivation on irrigated lands appears to be extending in this as well as in other districts. The principal market season in Madras is from January to March.

Although, as previously stated, the Madras crop owes its chief commercial value to the fact that a large part of it is bought for the French market, yet a good portion of the seeds are used in expressing oil in the local native mills. This industry, which appears to be increasing, is being encouraged by the authorities with a view to accustoming the people of the country to put their raw material through as many processes of manufacture themselves as they have facilities for. The bulk of the Indian manufacture of pea-nut oil is in the hands of the owners of ordinary native pestle-and-mortar pattern rotary mills. At Valavapur there are said to be 70 such mills, at Panruti 200 mills, and at Pondicherry there were formerly 200 mills.

Mills of European pattern were tried at Pondicherry and at Cudalore, but it was found that they could not compete successfully with the native mills. It is said that the oil expressed in the first pressing by the European mills was good, but that that obtained from the second pressing was dark, and consequently rejected in the European markets. The cake, being dry, wanting in oil, and powdery, was also rejected. So economically are the oil mills worked in Marseilles, that pea-nut oil is cheaper in France than it is in South Arcot, a standard price in Marseilles prior to the war being 45 francs per 100 kilos. (220 lb.)—that is, £4 13*s.* 6*d.* per French candy of 529 lb., whereas in Pondicherry it was £5 7*s.* per French candy. It is commonly estimated that 1 cwt. of dry kernels will yield about 5 gallons of oil. The seed produced on unirrigated land is more oily than that raised on irrigated land.

In 1915-16 shipments of pea-nut oil from Madras ports were 262,641 gallons, valued at £27,800. One of the chief markets for the South Indian pea-nut oil is Burma. Shipments of oil to Calcutta have fallen off as a result of the opening of oil mills there, but the traffic in the nuts has correspondingly increased. Locally, the oil is extensively used in cookery. As an illuminant it is now recognised as having but a feeble power. It is sometimes employed for adulteration of gingeli (sesame) oil and coco-nut oil. The oil is also used in tanning leather. At Panruti and near Pondicherry, as also in Europe, it is employed in the preparation of a red dye from the *Morinda citrifolia*. The oil cake—the residue of the seeds after pressing—is largely used by native farmers as a cattle food, and as a manure for paddy, sugar cane, and plantains. In France, where the oil-pressing industry is highly developed, the oil is used as a salad oil for cooking purposes, in canning sardines, in the preparation of margarine, and in the manufacture of white soap.

HANKOW AS A MANUFACTURING CENTRE.

If one will glance at the map and see Hankow or the Wuhan cities' location connected with the outside world and the interior parts of China by the natural waterways and the existing and contemplated railways, its facilities as a manufacturing centre will be apparent. It has often been remarked that this would be a good place for the investment of capital for manufacturing articles that could be made from the natural resources of China. It is situated some 600 miles up the Yangtze River and is in the heart of China, where are collected a number of the known products of this Republic. It has not become an important centre for manufacturing articles for export, but it is producing considerable quantities of articles that are necessities and some for export.

Of the manufacturing plants in this district, the Hanyang Iron and Steel Works stand easily first in importance, particularly when considered in connection with the improvements being made at Tayeh for the production of different kinds of metal. It may be said to be the first plant in China. Other important plants are the Yangtze Engineering Works, the Hankow Iron and Engine Works, the Government Arsenal, the Government Powder Factory, the Government Mint, two modern paper factories, two cotton mills, two antimony smelting mills, eleven oil mills (of which eight are modern), one nail and needle plant, nine plants manufacturing egg products, one large cold storage plant, two ice plants, five flour mills, one cement works, two brick and tile plants, two modern aerated-water works, four electric-light plants, one cigarette factory, one woollen mill, one silk factory, three hydraulic presses, six tea factories, a cask factory, saw mill, candle factory soap factory, distillery, tannery, and a match factory.

The foregoing plants use more or less modern machinery, and some of them are under European management and have foreign capital invested in them. Besides these, there are a large number of small works employing antiquated methods for the manufacture of cotton thread and cloth by handlooms from grass and bamboo. Also timber is sawn by manual labour, matches are turned out from small plants, flax is spun, rope is made, and various other domestic articles are produced by primitive methods, but which are useful in the economic industries of the country. To these might be added a number of other metal-working plants, as white brass, silversmiths', and other articles of small importance.

It would seem, writes the United States Consul-General at Hankow, that that city offers wonderful opportunities for the establishment of modern factories for the use of raw products, which are plentiful in this section of China. Some sites are available within the concessions, and it is thought that many sites could be arranged for without at reasonable prices; labour is cheap, electricity is obtainable at reasonable rates, coal is conveniently near with easy water transportation, and river shipping facilities are ample for the conveyance of manufactured articles to remote districts of China and overseas.

When peace returns some authorities have said that Hankow is destined to be the centre of the new development in China. There are many reasons, adds the Consul-General, to accept this statement as a reasonable forecast of the future of the port.

GUATEMALAN SUGAR INDUSTRY.

Next to coffee, sugar is the most important crop of Guatemala. While the cane flourishes in almost every region from the level of the sea to an altitude of 5,000 ft., the chief sugar districts are in the provinces of Escuintla, Mazatenango and Solola, all on the Pacific Coast. The principal variety grown in the Republic, known as "Jamaiquina," was introduced from Jamaica. It grows luxuriantly, frequently reaching a height of 8 ft. and a diameter of 2½ in.

Another favourite variety which is planted extensively in the coast districts is known as "Cristalina." The cane is usually planted from August to October, but it can also be planted in the early spring with good results. The area devoted to the cultivation of sugar in 1916 was 76,352 acres. The average production is about 42 quintals (of 101·4 lb. each) per acre. As yet the production of sugar in the Republic is mainly in the hands of natives. There are some German- and British-owned estates, but very few plantations controlled by American capital.

It appears from a report by the United States Consul at Guatemala City that there are twenty sugar mills in the Pacific Coast region, each having an average crushing capacity of 12,000 quintals (540 tons) per day, and several smaller mills. The machinery used in the sugar mills is modern, and prior to the war was imported mainly from the United Kingdom and Germany. The grades of sugar manufactured are 86 to 89 brown sugar, and from 96 to 99 white sugar. The quality of sugar produced is declared to be excellent, and there is a large local demand for the product. The sugar exported is principally the raw product known in Guatemala as "moscabado" (muscovado). During 1915 Guatemala exported 109,188 quintals of sugar, valued at £67,000. Of this amount 63,671 quintals were sent to the United States, 25,190 quintals to Honduras, and the remainder to Panama and other coun. ies of Central America.

The Guatemalan sugar industry has experienced a steady growth and de elopment, especially during the past few years. rices having stimulated growers to aug. production by increasing their pl

·5 lb. of

using improved methods and machinery. So far as is known, no systematic attempt has been made to improve the varieties of cane grown; but it is understood that the Agricultural Department of Guatemala has formulated plans for experimental work with this object in view.

The year 1916 was one of exceptional prosperity with the sugar planters, the production of sugar amounting to some 300,000 quintals, valued at £277,000, and the indications are that the industry will continue to develop and expand.

ENGINEERING NOTES.

The Hauling Power of a Locomotive increased by a Steam Tender.—By the placing of cylinders under the tank of an old engine frame, retired from service, the Southern Railway Company of the United States of America is enabled to increase the power of modern locomotives. The new freight engines thus equipped are the 2-8-2 class, with cylinders 27 × 30 in. and 63 in. driving wheels. They weigh 136 tons, with 109 tons on the drivers. The old engines now converted into tenders are of the 2-6-0 and 2-8-0 classes. The boiler is removed and replaced by a tender tank carrying 8,000 gallons of water and 12 tons of coal. Pipes with flexible connections lead from the steam-chests to the superheater on the engine, and provision is also made for taking steam direct from the boiler when necessary. The exhaust is carried to a vertical pipe at the rear of the tank. A power-operated reversing gear is applied and is controlled from the cab. A steel casting is placed between the frames at the forward end for the draw-bar connection to the engine, and a similar casting at the rear end carries the coupler and draft rigging. The 2-6-0 tender has 54 in. driving wheels and 19 × 24 in. cylinders. Its weight, loaded, is about 76 tons, with 62 tons on the drivers. With this power-operated tender instead of the ordinary tender, the draw-bar pull of the engine is increased more than 33 per cent., and the engines haul 1,400 and 1,600 tons where they formerly hauled 1,100 and 1,200 tons. At the same time the coal consumption per 100 ton-miles is reduced to about 12 lb., as compared with 18 lb. for the new engines without steam tenders and hauling the lighter loads. Seven large freight engines are now equipped in this way. This method of increasing the power of locomotives is the revival of a very old idea to meet modern conditions, the plan having been employed to a small extent in England many years ago. This extract is from the *Engineering News Record*.

Floating Tides.—A plan, says the *Engineer*, whereby it is believed large consignments of coal may be floated down the Ohio River at low stages on artificial "tides," is being considered. The "tides" are to be produced by releasing the water impounded behind the dams which have been constructed in the river between Pittsburg and Cincinnati. According to Colonel Beach, the feasibility of the plan was demonstrated by trips, when 20,000 tons of coal were carried from near Huntington, West Virginia, to Cincinnati on the breast of such a "tide." Shippers declare it would have required 350 coal cars to have transported this shipment. It is declared artificial rises in the river's stage may be created every ten days or two weeks if shippers decide to co-operate in the adoption of the scheme, which is urged on as a means of relieving any shortage of a railroad-truck supply.

Electrolytic Iron for Commercial Use.—The *Scientific American* says that a French iron company has succeeded in producing electrolytic iron on so large a scale, in retorts absorbing as much as 20,000 amperes, that the Boucheger and Viallet works at Grenoble, which hold a concession of the company's patents, have already commenced the manufacture of pipes of large size from electrolytic iron. These are 13 ft. long, 3·9 to 7·8 in. in diameter, and ·6 in. thick. These tubes are employed for various industrial purposes, such as conduits for water, steam or compressed air. They have given entire satisfaction in practical use. The iron obtained by this process is said to be entirely different from ordinary iron, both in aspect and in properties. From the magnetic point of view it is possessed of a very high permeability and a low degree of hysteresis, making it particularly valuable for the manufacture of motors and transformers; from the mechanical point of view it possesses great strength and a considerable degree of extension. The tubes are expected to replace successfully the German tubes of which Mannesmann held a monopoly before the war.

Disintegration of Tunnel Lining.—Mr. C. A. Newhall describes a deterioration of the concrete lining in two tunnels on the Great Northern Railway, U.S.A., in a paper submitted to the Pacific North-West Society of Engineers. The older structure is the Cascade Tunnel, which was finished in 1899, and certain scaling of the concrete caused the Seattle Tunnel, four years younger, to be examined. Both were lined with monolithic concrete of ordinary composition, and both were found to be suffering from the same two complaints—only in their initial stages in the younger structure. The less important action was caused by the porosity of the concrete allowing the water at the back to ooze through and to carry away the cement. Mr. Newhall stated that the disintegration was due to the carbon dioxide in the water combining with the carbon compounds in the cement to form a calcium bicarbonate quite soluble and easily washed away; the concrete consequently got "mushy" at the surface without any swelling or forming of extraneous matter. The more serious defects—designated "sulphate disintegration"—were due, in his opinion, to the sulphur in the locomotive gases becoming oxidised, and eventually changing to sulphurous and sulphuric acid. These acids condense on the lining and react with the cement to form calcium salts,

which, in the presence of the water from the steam, crystallise as gypsum. This enlarges in the cracks and causes the characteristic swellings, with the formation of soft white mud, and the breaking off of the concrete.

OBITUARY.

KHOO CHEOW TEONG.—Intimation has been received from Penang of the death of Mr. Khoo Cheow Teong, who was well known in the Far East in connection with the trade of Malaya. He was born in Penang in 1849, and educated in a Chinese school. From 1878 to 1904 he was "Captain China" of Asahan, Dutch East Indies, a post somewhat resembling that of Protector of Chinese in the Straits Settlements. Mr. Khoo Cheow Teong was elected a member of the Society in 1909.

GENERAL NOTES.

SILVER AND BRONZE CURRENCY.—The Chancellor of the Exchequer stated in the House of Commons on October 24th that the total amount of silver and bronze currency issued for the United Kingdom from the Mint in the years 1914-1917 was as follows:—

—	Silver.	Bronze.
	£	£
Year ended July 31st, 1914 .	1,247,720	346,124
,, ,, ,, 1915 .	7,404,087	241,900
,, ,, ,, 1916 .	10,352,026	314,925
,, ,, ,, 1917 .	4,514,107	547,590

The total amount of silver and bronze currency withdrawn from circulation in the United Kingdom in the same years was:—

—	Silver.	Bronze.
	£	£
Year ended July 31st, 1914 .	602,045	12,609
,, ,, ,, 1915 .	145,457	5,926
,, ,, ,, 1916 .	91,545	3,441
,, ,, ,, 1917 .	191,695	2,056

DAMAGE TO WHEAT-STACKS BY MICE.—While the world is crying out for wheat, says the *Colonial Journal* for October, it is going to waste in Australia. It is being eaten up, and by a new plague—mice. When wheat could be shipped promptly these depredations were not serious, but now that it has to be stacked anyhow and left waiting indefinitely, the bags are riddled and the damage is enormous. There were in June some seven million bags waiting, and huge stacks have degenerated into jumbled masses. A loss of about 10 per cent. is expected. In some places the weevil is worse than the mouse.

MODERN GARDENING.—In his "Memories of Sixty Years" (Cassell & Company) Lord Warwick says that in their best aspects all our finest gardens are modern. When he was a young man the proprietors of large country houses seldom saw their gardens at their best, and consequently gardening languished. When the spring had come the owners would go up to London for Parliament and the season, only to return in the autumn. "It was the advent of the 'week-end' that brought about the renaissance of gardening in England. The owners of big places discovered not only their gardens, but the landscape gardener and the importer of rare shrubs, trees and rock-garden plants from all parts of the earth, even as far as China. The old style of formal and Italian gardens passed, and an attempt was made to encourage the growth of trees, shrubs and flowers in relation to the landscape." In referring to his activities in earlier life, Lord Warwick recalls his election as Chairman of the Central Chamber of Agriculture, "representing very many agricultural societies throughout the country and meeting in London at the rooms of the Society of Arts."

COAL GAS FOR MOTOR TRACTION.—Mr. E. S. Shrapnell-Smith, Petroleum Economy Department, in a speech at Manchester on October 12th, said it is hoped that within the next few months many thousands of commercial motors will be equipped to run on town gas, the average cost of which may be said to be less than one-third per mile run of the cost of petrol for corresponding work. Not only should town gas enable economies to be made in the cost of transport, but the margin of saving, compared with the cost of petrol, should be high enough to leave available a handsome contribution from motor traffic towards the reconstruction of roads without unduly hitting haulage interests.

PANAMA CANAL MOTOR VESSELS.—The Panama Canal Authority has recently completed at its Balboa shops two interesting motor vessels which are intended to act as supply boats to the ships using the great inter-ocean waterway. The vessels are 85 ft. long by 20 ft. beam (moulded), by 9 ft. depth (moulded), and displace 140 tons at their load draught of 5 ft. 6 in. Their designed speed, says the *Syren*, is seven miles an hour, but under moderate load they have done as much as nine miles an hour. They are single-screw ships, their propelling power being in a Nlesco Diesel engine developing 120 b.h.p. at 350 r.p.m. The motors, which are started by means of compressed air under a pressure of 900 lb. per square inch, run on a low grade of fuel oil. The auxiliary machinery consists of a 24-h.p. Palmer petrol engine driving an air compressor, a dynamo of three kilowatts capacity, a centrifugal pump, and a bilge pump. The fuel tank is in the fore peak, and has a capacity of six tons. As the consumption is a gallon per mile, the vessels have a cruising radius of about 2,000 miles.

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FRIDAY, NOVEMBER 9, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Sixty-Fourth Session will be held at 4.30 p.m. on Wednesday, November 21st, when an address will be delivered by ALAN A. CAMPBELL SWINTON, F.R.S., Chairman of the Council. The subject of the address will be "Science and its Functions."

The following arrangements have been made for the meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m. (unless otherwise announced):—

NOVEMBER 28.—G. HOLT THOMAS, Chairman, Aircraft Manufacturing Company, "Aerial Transport after the War."

DECEMBER 5.—SIR DUGALD CLERK, K.B.E., D.Sc., F.R.S., Inaugural "Trueman Wood" Lecture. ALAN A. CAMPBELL SWINTON, F.R.S., Chairman of the Council, will preside.

DECEMBER 12.—LORD CHARNWOOD, "Technical Training for Disabled Soldiers and Sailors."

DECEMBER 19.—PROFESSOR J. WEMYSS ANDERSON, M.Inst.C.E., M.I.Mech.E., Dean of the Faculty of Engineering and Lecturer in Refrigeration, University of Liverpool, "The Cold Storage Industry." The HON. SIR THOMAS MACKENZIE, K.C.M.G., High Commissioner for New Zealand, will preside.

COLONIAL SECTION.

Monday afternoon, at 4.30 p.m.:—

NOVEMBER 26.—LIEUT.-COLONEL THE HON. SIR JOHN MCCALL, M.D., LL.D., Agent-General for Tasmania, "Land Settlement Within the Empire." The RIGHT HON. WALTER H. LONG, LL.D., F.R.S., M.P., Secretary of State for the Colonies, will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 13.—D. T. CHADWICK, I.C.S., "The Trade of India with Russia, France, and Italy." The RIGHT HON. LORD ISLINGTON, G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

Papers to be read after Christmas:—

LORD LEVERHULME, "The Relations between Capital and Labour—Reasonable Hours, Co-partnership, and Efficiency."

SIR WILLIAM H. CLARK, K.C.S.I., C.M.G., Comptroller-General of the Commercial Intelligence Department, "The Organisation of Commercial Intelligence." The RIGHT HON. LORD FARINGDON will preside.

LIEUT.-COL. SIR ROBERT ARMSTRONG-JONES, M.D., F.R.C.P., F.R.C.S., "The War and its Effects on the Mind."

ALEXANDER NEWLANDS, M.Inst.C.E., Chief Engineer, Highland Railway, "Water Power in the British Isles."

FRANK STUART COURTNEY, M.Inst.C.E., Consulting Engineer to the Royal Agricultural Society of England, "Agricultural Machinery."

MARTIN O. FORSTER, D.Sc., Ph.D., F.R.S., "Organic Chemistry in Relation to Industry."

MAURICE B. ADAMS, F.R.I.B.A., "Picturesque Architecture." SIR ASTON WEBB, K.C.V.O., C.B., R.A., F.S.A., F.R.I.B.A., will preside.

ALFRED DICKINSON, M.Inst.C.E., "Water Power in India."

H. M. SURTEES TUCKWELL, M.I.Mech.E., "The Tata Iron and Steel Works" (India).

SIR HENRY LEDGARD, late President, Upper India Chamber of Commerce, and Member, Board of Industries, United Provinces, "The Indian Tanning Industry."

Sir Walter Egerton, K.C.M.G., LL.D., Governor of British Guiana, 1912–17, "British Guiana."

C. du P. Chiappini, Trades Commissioner for the Union of South Africa, "The Industrial Resources of South Africa."

The following series of papers has also been arranged dealing with the Application of Scientific Research to the Development of particular British Industries:—

Reginald S. Clay, D.Sc., Principal of the Northern Polytechnic Institute, "The British Pianoforte Industry."

George Martineau, C.B., "The Sugar Industry."

John B. Farmer, D.Sc., M.A., F.R.S., F.L.S., Professor of Botany, Imperial College of Science and Technology, "The Rubber Planting Industry."

W. Lawrence Ball, Sc.D., Manager of Cotton Investigations for the Fine Cotton Spinners' and Doublers' Association, "The Cotton Industry."

Percy Groom, M.A., D.Sc., F.L.S., Professor of Technology of Woods and Fibres, Imperial College of Science and Technology, "The Timber Industry."

Sir William George Watson, Bt., Chairman of the Maypole Dairy Company, "The Manufacture of Margarine in Great Britain." Sir Arthur H. D. Steel-Maitland, Bt., M.P., will preside.

Indian Section.

Thursday afternoons, at 4.30 p.m.:—

January 17, February 14, March 14, April 18, May 30.

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

February 5, March 5, April 30.

Cantor Lectures.

Monday afternoons, at 4.30 p.m. (unless otherwise announced):—

H. C. H. Carpenter, M.A., Ph.D., M.Inst. M.M., A.R.S.M., Professor of Metallurgy, Imperial College of Science and Technology, "Progress in the Metallurgy of Copper." Three Lectures.

December 3, 10, 17.

Charles R. Darling, A.R.C.Sc.I., F.I.C., Lecturer in Physics, City and Guilds Technical College, Finsbury, "High Temperature Processes and Products." Three Lectures.

January 21, 28, February 4. At 8 p.m.

Edgar Crammond, Secretary of the Liverpool Stock Exchange, "The Economic Condition of the United Kingdom before the War: The Real Cost of the War: and Economic Reconstruction." Three Lectures.

February 18, 25, March 4.

J. Young, A.R.C.S., F.C.S., Chief Instructor in Science, Royal Military Academy, Woolwich, "Military Explosives of To-day." Three Lectures.

April 8, 15, 22. At 8 p.m.

Cobb Lectures.

Professor Henry R. Procter, D.Sc., F.I.C., Leather Industries Department, The University, Leeds, "Recent Developments of Leather Chemistry." Two Lectures.

May 13, 14.

Juvenile Lectures.

These Lectures will be given on Wednesday afternoons, January 2 and 9, 1918, at 3 o'clock. The lecturer and subject will be announced in the *Journal*.

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

MEMORIALS AND MONUMENTS.

By Lawrence Weaver, F.S.A.

Lecture II.—Delivered March 12th, 1917.

My last lecture was devoted mainly to the spirit of memorial design and to the history of the development in England of some of the simpler types of monument. I chose the subjects for illustration rather because of their suitability as influences for modern designers than because they represented at all an adequate survey of English memorial art. This great art was in mediæval times essentially a sepulchral art—the art of the tomb, its derivatives and architectural accessories. Modern memorial art tends to neglect the aspects of death and rather to express living qualities and activities. It dwells less on the morbid side, which is so acutely represented by the Nightingale monument in Westminster Abbey, where Death in the person of a skeleton emerges from a tomb and strikes up with a spear at the fainting figure of a lady falling back into her husband's arms. So theatrical a conception strikes a jarring note in these days, and was indeed not fairly typical of eighteenth century sculpture in

England even of the more dramatic sort, being the work of the French sculptor Roubillac. The table tomb surmounted by a recumbent effigy of the deceased continues to be employed mainly for great statesmen and ecclesiastics, and only to a small extent for private persons, and then usually in family or private chapels. There is a practical reason in this as well as a change in sentiment. Our older churches have little available free floor space. Our modern churches are generally planned with a strict regard to the provision of the maximum amount of seating accommodation, and such planning provides few spaces appropriate for the setting of cenotaphs. In bygone days the church and churchyard and monastic enclosures were the only places for sepulchral monuments, because the memorial was generally set immediately over the place of burial whether in the building itself or in the churchyard. Modern hygienic ideas have abolished burial within churches save in a few cases, such as Westminster Abbey, St. Paul's, and other cathedrals, where this honour is still paid to those who have done conspicuous service to Church or State. Even this convention is dying, and with it the tomb effigy. It is worth noting that of the three great statesmen whose memorials have lately been placed in Westminster Abbey—Sir Henry Campbell-Bannerman, Mr. Joseph Chamberlain, and the Marquess of Salisbury—only the last is commemorated by a tomb memorial; the other two are represented by portrait busts set on the wall.

There remain the innumerable memorials set up, not in churches, but in colleges, schools, public buildings of various sorts, and in open spaces, where tomb forms would obviously be very inappropriate. The problem before the designer of memorials, therefore, resolves itself into the treatment of a wall monument in nine cases out of ten, and I shall devote most of my attention to-day to this type. Next week I hope to deal with the larger outdoor monument. But first there comes the question, Who is to design our memorials? And on a successful and satisfactory answer to this question depend the beauty and fitness of the thousands of memorials to individuals and to groups of men which will follow the present world conflict. The last occasion for the provision of a large number of memorials in this country was the South African War of 1899–1902. Some years after, there was published a volume in which the author attempted to illustrate all the monuments, both regimental and individual, which had been set up in memory of those who gave up their lives in South Africa. The purpose of the author of that book was one of pious record—he took no account of the æsthetic merits of the memorials illustrated—good and bad appear side by side on the printed page. It is hardly possible to exaggerate the persistent vice of their design. Clumsy and definitely ugly forms, the misuse of materials, and, most noticeable of all, deplorable lettering combine to give a very distressing picture of our memorial art twenty-five years ago. This is mainly due to the fact that English people generally had not grasped—I fear it is true to say, have not grasped—that monuments are an artist's work. The prevailing notion of the appropriate action is to go to a shop which provides such things and to let them do their worst. For churchyard memorials the Euston Road is supreme, and even the Euston Road is mainly concerned to act as middleman to the wholesale provider of stock patterns made in Aberdeen and Carrara. The making of brasses, one of the most exacting fields of memorial design is largely the province of the clerical tailor, who farms them out to the baser sort of working ironmonger, and the large stores have their monument departments with drawers full of stock patterns devised to suit all reasonable tastes. No form of art has been so wholly commercialised, with results to be appreciated intimately by anyone who visits any cemetery. The stock pattern is not in itself a bad thing: a coin is a stock pattern reproduced mechanically by the million, and may yet be a miracle of fine art; but if it is to be satisfying the stock design must be the work of a great artist. Moreover, a coin is an impersonal thing, whereas a memorial is perhaps the most personal form of art. Its sole purpose and only justification is to give shape to emotions of praise and gratitude for personal acts and personal lives. If it is to achieve this adequately, it must have a character of its own, and must moreover express that character in terms of beauty. To ensure an apt memorial, and to avoid those deplorable examples which merely add a new terror to death, it is necessary to seek the serious artist. Whether he be architect or sculptor, or the craftsman who is not merely a fashioner of other men's ideas but an inventor of pleasant forms, is a matter which depends on the type of memorial desired. For any monument of importance I would strongly urge the collaboration of architect and sculptor. It is true that some of the greatest monuments of the Italian Renaissance were the creation of a single artist; but we cannot claim to produce men of

such amazing versatility as Leonardo and Michelangelo, at once architects, engineers, sculptors and painters, employing every medium with the same facility. We have had one such, Alfred Stevens, a Florentine born out of due time, and to his master hand we owe what is perhaps our greatest monument—that of the Duke of Wellington in St. Paul's Cathedral; but during his lifetime he was treated with characteristic neglect. From whatever causes, and it is no business of mine to trace them now, there is a gap between the arts of sculpture and architecture to be bridged somehow if those compositions which are both sculptural and architectural are to be successful. Monuments which are the sole work of the sculptor are apt to fail by reason of bad architectural detail, as, for example, in the mouldings of a pedestal. Monuments which are architectural in the main often disappoint by reason of the awkward application of sculpture and by its poor quality, occasioned by the employment of a second-rate sculptor. The association of able sculptors and architects on equal terms seems the best solution of the problem.

[Slides shown:—

Gilt bronze tablet, with bust of Norman Shaw, New Scotland Yard. Architect, W. R. Lethaby. Sculptor, Hamo Thornycroft, R.A.

Tablet at Marienbad to King Edward VII. Architect, W. R. Lethaby. Sculptor, Stirling Lee.

Wall memorial to R. W. Boyce, Liverpool University. Architects, Willink and Thicknesse. Sculptor, C. J. Allen.

G. F. Bodley's Memorial, Holy Trinity, Kensington. Architect, Edward Warren. Sculptor, Thomas Murphy, Jun.

Cranmer, Jesus College, Cambridge. Architects, Richardson and Gill. Sculptor, Bruce Joy.

Mrs. Ashley, Romsey Abbey. Architects, Richardson and Gill. Sculptor, Emil Fuchs.

South African Memorial, Radley College. Architect, Sir T. G. Jackson, R.A. Sculptor, Sir George Frampton, R.A.

Memorials to Ernest Croft and E. F. Trevelyan. Architect, Basil Oliver. Sculptor, Allan S. Wyon.

Memorial to Randolph Caldecott, St. Paul's Cathedral Crypt. Sculptor, Alfred Gilbert.

Memorial to Marquess of Winchester, Amport St. Mary. Sculptor, Sir William Goscombe John, R.A.

Memorial to General Lockhart, St. Giles's, Edinburgh. Sculptor, Sir George Frampton, R.A.]

This is especially desirable when the proposed monument is to be attached to an existing building or is to take its place as an organic feature of some larger scheme of site-planning or town-planning. The especial contribution of the architect in such a case will be the establishment of a right relation between the monument and its environment, for lack of which so many ambitious schemes have made shipwreck.

In the case of the smallest memorial, however, the importance of a right setting cannot be exaggerated, and a study of the building will determine not only the right form, but also the right materials. It is unfortunately true that many a memorial is designed and made without its designer ever having seen the building in which it is to be set up. He is told that there is a space on the wall which allows the monument to be 3 ft. wide and 5 ft. high, and is left to imagine the prevailing colour of the building, the way the light falls, the angles from which the monument will commonly be seen, and other pertinent factors. If æsthetics had a code of laws, there should be one of Draconian severity to deal with men who design a monument, however simple, without careful study of its setting. That is not to say that in these days of eclecticism—as I believe, of inevitable and justified eclecticism—it is necessary that a memorial should follow its setting in the character of its design. It is to me a preposterous claim that a monument in a Gothic building should therefore be Gothic rather than classical. Design is personal to its inventor, and the designer must be given reasonable freedom. Design is not a matter of pattern books out of which the designer hashes up a composition consisting of so many conventional forms and ornaments. Memorial art should express the character of the person commemorated in terms of the artist's genius—if that be not too strong a word, at least with reference to his æsthetic outlook. Sound and convincing art is not an affair of historical styles, which have too long been treated with idolatry, but of style, which may be wholly absent from a composition claiming every grammatical and stylistic virtue. All satisfying art is conceived in the power of authentic traditions, but if it is to be vital it must be personal to its author and convincingly of its own day and generation. It ought to show growth, and for that reason only I suggest that a memorial set in an existing building should be conceived in the spirit of a later rather than an earlier tradition. I think that a memorial in a Gothic manner set up in one of Wren's churches would make me feel uncomfortable—it would seem an inversion of good order, whereas something in a classical manner does not, if

good *per se*, seem an unfit addition to a mediæval church or a modern church in a Gothic manner.

But in all these matters the main thing is to give the artist or artists employed, not perhaps a perfectly free hand, but a very wide discretion. Many monuments, like many buildings, have been made ridiculous by the fettering of the artist's judgment by committeemen who may be admirable husbands and fathers, but are imperfectly educated in æsthetics. The main function of a client, whether an individual or a committee, is to lay down the main factors governing the design—its general character, the nature of the inscription and the amount of money to be spent, leaving the artist to work out his scheme without hampering him with clouds of specified details often mutually contradictory. If that principle be accepted, the one all-important thing is to secure the services of an artist of proved skill, whose work is recognised by his brother artists as serious and sincere. Unfortunately, the designer of a memorial often secures the commission because he is related to the chairman of the committee, or for some reason other than his æsthetic qualifications. Public schools, for example, are apt to confine their artistic favours to their old boys, with results frequently distressing, because it is not given to every school to produce able architects and sculptors. On the actual method of choosing designers I can offer no valid advice, beyond the suggestion that "by their works ye shall know them." Like the statesman suddenly asked to define an elephant, I can only say that I cannot produce a definition of an artist, but that I know one when I see one. Not the least of an artist's difficulties is the order so often given that a monument shall be in this or that style, Gothic, Jacobean, or what not. To some men it is given to work freely in many manners, but to others art presents itself in narrower fashion. If a man whose outlook is definitely classical is bidden to design a Gothic monument which means nothing to him, and may even be positively distasteful, he has to face various unpleasant alternatives. He may decline the commission, or essay the task without enthusiasm with results almost certainly unsuccessful, or employ a "ghost" with the required taste. If the client is determined on a memorial of a specific type, he will be wise to assure himself that the artist proposed is in sympathy with the scheme, and failing that to cast about for someone who is. But the important thing is to leave the artist alone. It is his function to consider the right expression of the qualities of the man or group of men to be commemorated in the light of his own taste, conditioned by such factors as setting, local materials, etc.

[Slides shown :—

Alabaster tablets to Frederick Bulley and T. C. Whetmore. **Architect, Thomas Garner.**

Praying figure. Monument to the Hon. Francis Meynell, Hoar Cross Church. **Architect,** Cecil G. Hare.]

On the subject of materials much may be said. An unfortunate theory exists that brass, white marble and alabaster have some peculiar qualities which mark them out for employment in monuments to the exclusion of other materials. For churchyard monuments granite is held to be peculiarly suitable—a theory due, no doubt, to the skill with which wholesale providers at Aberdeen have hypnotised local undertakers and monument merchants. Polished red granite is to me one of the most unpleasant materials available, and its refractory nature limits unduly the character of the design to which it may be worked. Pure white marble is also a rather unhappy material for outdoor work. Especially in London and other big towns it weathers badly, and few objects are more desolate than dirty white marble under a grey sky. The yellowish white marble, known as Roman, is more suitable. But what can be more admirable than fine Portland stone or Hopton Wood stone, typical English materials that weather faithfully and naturally under English skies? For indoor monuments there is, of course, not the weather argument against white marble, but there is always something satisfactory in the use of native materials. That brings me to alabaster, an essentially English stone, always used freely for monumental work in bygone days. No material is more charming if rightly treated, but its veined and cloudy character is not always remembered. Its value is in its colour and figure, and it should not be intricately carved with a mass of detail. It calls for broad treatment and the absence of delicate mouldings, and it is not very suitable for inscription tablets, because its natural markings tend to make lettering illegible. For such tablets there is much to be said for Hopton Wood stone. It has a pleasant, quiet colour, and cuts cleanly.

Brasses make a special appeal to our historical sentiment, and nothing could exceed the fitness for purpose and intrinsic beauty of some of the mediæval examples. They are the repositories of much of our knowledge of ancient dress, but the designing of modern brasses requires very

careful thought. When they are simple inscription plates adorned, say, with heraldic achievements and conventional ornament only, the problem is comparatively easy, but any attempt to show the person commemorated in modern costume is almost bound to lead to disaster. The portrayal of a great engineer in trousers on a Westminster Abbey brass is a case in point, and there are some military brasses in St. Paul's Cathedral, notably one in the crypt to the besieged garrisons of the Transvaal, 1880-81, which have all the qualities a brass should not have. At the same time the difficulty will not be overcome by showing soldiers of to-day in mediæval armour, and the treatment of the figure is therefore best left alone. A good exception, however, to this suggested rule is found in Mr. Byam Shaw's brass to Lady Duckworth in St. David's Church, Exeter, where an angel holds a scroll with the inscription. This, however, is a frank exercise in the mediæval manner.

Modern feeling is seen in a brass in Ripon Cathedral designed by Mr. Aymer Vallance to the memory of E. B. Badcock. The treatment of the angel and the floral ornament give this example a personal quality, but the lettering is freakish. A very good treatment is seen in the wreath and coat-of-arms on the grave of Sir John Millais in the crypt of St. Paul's Cathedral, designed by Norman Shaw with the aid of John Clayton. Mr. J. H. M. Furse has done several simple brasses in All Souls Chapel, Oxford, relying simply on coats-of-arms, swags, simple borders and good lettering, and Mr. Eric Gill, Mr. MacDonald Gill, Mr. Edward Dorling and Mr. George Kruger are able exponents of the simple lettered plate. A touch of gaiety is given by treating coats-of-arms in their correct colours with enamel, and variety is given by filling the incised lettering with different coloured waxes or mastics. If waxes are not used the lettering needs to be cut V-shape with greater care, and the lettering may be made quite legible by being coloured with "flatted" oil paint, which can readily be renewed. Wax filling is apt to fall out in time, and this gives a shabby look, for the incising is necessarily left rough and jagged to give a "key" for the wax.

Bronze is often preferred for its deeper colour, but in England we never adopted the cast bronze plates in very low relief, of which there remain many German examples by Peter Vischer and other artists. Sir Robert Lorimer's floor slab to Bishop Dowden, on the floor of St. Mary's Cathedral, Edinburgh, is an admirable modern example of what may be done in this direction. Sir W. Goscombe John's bronze wall tablet in St. Paul's Cathedral crypt to the memory of the war correspondents who died in South Africa is somewhat on the same lines. A seated figure of a woman and an inscription are the only elements and the work is in low relief. The same artist's memorial to the Coldstream Guards, also in St. Paul's but in the upper church, shows a soldier supporting a wounded comrade, and in the background a group of Guardsmen in various early uniforms of the regiment look down on the scene and symbolise the pride of the regiment in the exploits of their comrades in South Africa. This seems to me a rather forced and theatrical treatment. Too much is attempted, and the tablet is far less successful than the simpler one to the war correspondents, with its more direct appeal.

The English brass was always engraved, and the art of repoussé work never flourished on our soil. The revival of craftsmanship in England during the last forty years has, however, brought into common vogue the beating up of thin metal. The exponents of *L'Art Nouveau* found it very attractive as a medium for their extravagances because a big show can be got by a very little effort, and it has in consequence become discredited as an amateurish affair. Provided, however, that the facility it affords of getting some sort of effect is not allowed to run away with the craftsman; and given a sober treatment of design, repoussé work may give a creditable tablet either in brass or bronze. Cast lead has been very rarely used, but delightful effects may be won in our most characteristic metal, as in a tablet to the memory of Lieut. Maurice Livingstone, at Westport, co. Mayo, designed by Sir Charles Nicholson. Colouring and gilding are traditional aids to the decoration of lead, and by their means a very rich effect may be gained. Engraved pewter is also capable of fresh and interesting treatment. Cast bronze with raised lettering has a special value from its imperishable nature.

Wood has been neglected as a material for memorials, apparently because it is not thought lasting enough; but there is a tablet of 1594 in South Ockendon Church which has stood for over 300 years, and that seems far enough to look ahead. The advantage of using wood is that a carved panel works so easily into the general architectural scheme of church or hall. Plain panels behind stalls in a school chapel, for

example, may be replaced by carved and painted memorials of old boys, and this has been done, and unhappily is still being done, with admirable effect in the chapel of Loretto School. It is desirable for the lettering on wooden tablets to be incised or left raised by the lowering of the background. In some cases the inscription is simply painted on, but that leaves it at the mercy of the sign-painter of the future who may be called in to renew the faded lettering. He will be likely to employ whatever unpleasant fashion of lettering may then be in vogue instead of following the fine Roman types which we may hope will generally be used to-day, when there is no excuse for adopting bad models.

Lettering is all-important. It needs to be legible as well as beautiful, and for that reason it seems unwise to employ Gothic black letter, even for memorials in the Gothic manner, for it is usually wearisome stuff to read. A good modern exception to the contrary, however, is a black-letter inscription at Ewhurst, designed by John Francis Bentley. I see no reason why Roman lettering should not be used even on a monument which is Gothic in character, but for those who are pained by any lapse from historical accuracy there remain Lombardic capitals, such as we find on the tomb slab of Richard le Petit at Stoke D'Abernon Church, dated 1230 or thereabouts. The "lower-case" Lombardic (to borrow a term from typography) is very unsuitable, being even more difficult to read than black letter. For Roman lettering the supreme type, and one which can scarcely be bettered, is that of the Trajan column. Some of the Italian Renaissance tombs, such as Cardinal Portogallo's in St. John Lateran, by Filarete, show still more refined versions of Roman capitals, and the Italians carried lettering a great step further by the invention of small or "lower-case" letters, which seem not to have been used in monumental work before about 1500, though they must have been used in penmanship long before that. We are not obliged to believe the pretty legend that Petrarch invented italic writing. The contribution of the Renaissance carvers of inscriptions was to regularise a type which had originally been free and easy. The wanton irregularities which some modern letter-cutters have employed, such as omitting a letter and then inserting it small above the line, are pure affectation. The natural irregularities such as one finds in English country churchyard tombstones were the outcome of defective education, and are not to be adopted as models. Conscious variations from traditional forms are justified only when they put into circulation new forms which are in themselves beautiful, but these are very few. Most of the letterings which seekers after novelty acclaim as charming and original are mere distortions of good forms, and possess nothing but novelty. The block letter, which may be defined simply as a letter with strokes of uniform thickness without "serifs," is ordinarily very unpleasant, and I feel that it is very bald and unsuitable for monumental work. A month or two ago I should have said for any work; but the delicate block lettering now being employed by that great patron of the Arts, the Management of the London Underground Railways, compels me to modify so sweeping a condemnation. In fitness for purpose, the purpose being absolute legibility in advertisement notices, this lettering is perfect and its form is admirable. So true it is that every sort of form can be made acceptable to the eye if it is right of its kind. There is perhaps no bad art except the unthinking.

I mean these few disjointed notes on lettering, which is a very big subject, to serve no purpose but to draw attention to it. I wish every artist would study Mr. Edward Johnston's "Writing and Illuminating and Lettering," with a chapter on letter-cutting in stone, etc., by Mr. Eric Gill, a past master in this branch of craftsmanship. His own tablets to Francis Thompson and George Gissing are models of the right combination of the Roman tradition with personal design. Other admirable exponents of fine lettering are Professor Selwyn Image, Mr. Graily Hewitt and Mr. Percy J. Smith, but happily they have so many fellow-workers that good lettering promises to become as usual as it was once rare. Happily great printing and advertising firms, like Messrs. W. H. Smith & Son, are accustoming the public eye to what is good.

It is, however, not the specialist in lettering, but the designer of monuments who has to dispose the inscription in the space provided. Many an inscription, well lettered in detail, fails because it is too crowded. Comparison between the tablets on the tombs of Cardinal Portogallo, already mentioned, and of Pope Paul II., emphasise the richness of effect given by large well-spaced lettering and the poverty of smaller lettering and crowded words.

Heraldry is of great value in giving decorative interest to a monument, whether noble or simple, and with heraldry it is natural to group regimental badges and the jewels and devices of the Orders of Chivalry awarded for feats of

arms. Heraldic art is now emerging from a slough of misunderstanding long fostered by the ignorance of the so-called heraldic stationers who used to torture our friends' notepaper with the aid of Fairbairn's "Book of Crests." Most of the blunders made in the decorative use of heraldry arise from ignorance as to the original things portrayed, which were a shield adorned with distinctive charges, a helm surmounted by a crest and mantling which served the purposes of a modern puggaree.

By degrees, as the significance of these objects became lost through their disuse, the shield was given all manner of impossible shapes. The crest was dissociated from the helm, and degenerated into a twisted sausage which served as a stand for the crest. It would be unreasonable to demand a rigid adherence to the pure forms of heraldry such as we find in the early stall plates of the Garter Knights in St. George's Chapel, Windsor, which were fairly accurate representations of actual articles of knightly equipment. Heraldry has now become a conventional method of indicating genealogical history and all such conventions must be treated with reasonable elasticity so that they may fall in with the stylistic idea of the monument which they decorate. It is, however, perfectly feasible to translate the Gothic shield crest and mantling into terms of early Renaissance or rococo without losing sight of the fundamental character of the objects represented. The form may fluctuate, but the idea should persist. In simple memorials the value of heraldic achievements is in the opportunity they give for a little riot of swirling lines and colour which relieves an otherwise austere composition of mouldings and lettering. Even in so large and important a monument as Henry the Seventh's tomb in his Chapel at Westminster, the chief decorative interest is to be found in Torregiano's Florentine angels—four in all—who support the splendid shields of arms which are clearly the work of English craftsmen. For guidance in the decorative use of heraldry let me commend Sir William St. John Hope's "Heraldry for Craftsmen and Designers," published in Mr. Hogg's series.

Regimental devices give the designer a good deal of trouble because the sinister figure of the heraldic stationer and the ghosts of long dead War Office people stand between him and his regimental clients. Royal Warrants have laid down from time to time what is the badge (commonly and foolishly called a "crest") of a regiment. This is described in words, more or less in heraldic language, and is the device used on the regimental colour with the scrolls containing the battle honours. These words are interpreted either by the zealous but unheraldic ladies who embroider the colour or by the stationer who stamps the regimental notepaper. The generally debased and foolish forms thus given to the badge are apt to be treated by the regiment as though they had a sanction scarcely human. If an artist is bold enough to go back to the words of the warrant, and to put the elements there described into suitable form, he is likely to be regarded as an ignorant, if not a blasphemous, person; but that is the only sane course to pursue. Worse pitfalls even await the thoughtless artist. One regiment with which I am especially acquainted has on its colour a badge of peculiar merit; but some remote and forgotten colonel ordered notepaper in a fine artistic frenzy and bade the stationer use as the "crest" the current design on the tunic button. This is now reverently regarded as the regimental crest, and sundry attempts which I have made to put the case faithfully before regimental officers have been treated with the contempt they doubtless deserve. Certain favoured regiments, notably the Guards, have company colours as well as the King's Colour and the Regimental Colour, and these make splendid accessories for a Guardsman's memorial.

Representations of orders and crosses are also suitable decorations for a soldier's monument, and altogether the military memorial gives the heraldic enthusiast endless opportunities, which he will be wise not to grasp too liberally lest his design grow too busy. Heraldry is the best known of the recognised emblems, but for the soldier there are trophies of arms which the designer will be wise to conventionalise. Anything like a precise representation of modern military weapons would be a mistake. The monument merchant still rejoices in the form of tablet which is surmounted by a realistic busby or helmet, and a sword disposed conveniently below it. These objects generally go with an inscription in squat block lettering. It may be that the draughtsmen of these merchants are already compounding designs of which Sam Browne belts and putties form an integral part. In monuments of the most important sort emblematic figures may well have a place; but imaginative treatment of such a sort needs fine thought as well as fine treatment. What may be called narrative sculpture, such as low reliefs illustrating a charge on land or a bombardment afloat, was popular in memorials of the

Napoleonic and Crimean Wars, and even of the South African War; but realism of that sort must always be a very dangerous experiment, and when all is said can only be a sham realism distorting the facts of the fighting in order to produce some kind of coherent composition. By the same token single figures of soldiers in service uniform and in fighting attitudes are very rarely satisfactory. The best form of realism is the portrait pure and simple, whether it be a bust or a relief. It gives the personal touch which many crave and presents no special difficulties to the designer. After all, the finest element in symbolic art is that which faithfully gives a spiritual character; but, except in the case of a memorial to an ecclesiastic, it is difficult to provide symbols definitely Christian beyond cross forms, the Chi-Rho and other well-recognised elements, such as patron saints and angel supporters. Where angels are used it should be remembered that the practice of representing them as mawkish young ladies finds no authority in Holy Scripture, where those who are made known to us by name are represented by strenuous acts. It is rather in the churchyard than in the indoor memorial that the sign of our salvation is capable of adequate decorative expression; but the cross is a difficult form. The ordinary square-edged Latin cross cut out of a level slab is an uncompromising object with a harsh outline, and it seems wiser to adopt something of slab or shaft or obelisk form and embody the cross in it. The traditional type of village cross, with its tall shaft surmounted by a small cross or by a Calvary, still holds its own, and the Celtic or Runic crosses, especially those which blend Gothic and Celtic forms, give great opportunity for rich and symbolic detail. It is, however, a very dull expedient to copy some notable Irish or Scottish example in everything but the inscription. My late friend John Bonnor was especially skilful in maintaining the spirit of these early memorials while giving them distinctive contemporary detail. His recent and untimely death while superintending the carving of the detail of the new Canadian Houses of Parliament has removed an artist of exquisite perception and a fine sense of beauty. Much distinguished work would have come from his hand if he had been spared to us, and his death removed a notable personality of rare modesty as well as an original and imaginative artist.

It is not, however, to the art of mediæval derivation that we look exclusively, or indeed especially, for the churchyard memorial. Monuments which owe their character to Roman inspiration are especially appropriate for the commemoration of fighting men. We remember Sir Henry Newbolt's lines:—

> O strength divine of Roman days,
> O spirit of the age of faith,
> Be with us still in all our ways.

We are happily past the day when it was supposed that everything classical was pagan, and only the mediæval Christian. The classical idea of death lacked that undying hope which informs the Christian outlook, but it had qualities of strength and resignation which are worthy of admiration. We are now on the rising tide of a revival of those more austere classical *motifs* in architecture which were at their height when England was in the throes of the struggle against Napoleon's attempt at world domination.

Æsthetic history is in accord with national history and, as our ancient enemies of a century ago are now bound with us by ties of mutual sympathy and admiration and by a common peril, it is natural enough that we should turn again to those classical models on which the monuments of the Napoleonic era were based, and to the French monuments themselves. But art is free. With Walter Pater let us hear all voices, remembering that we are the heirs of all artistic ages, and that every tradition of sound work is valid for us if it expresses in authentic fashion a sincere thought or a worthy emotion in terms of beauty.

PORCELAIN TRADE IN MALAYA.

There is a considerable trade in crockery and porcelain in the Malay Peninsula, of which, prior to the war, Germany had a bigger share than the United Kingdom. According to the statistics of the Straits Settlements, the value of imports and exports for the last four years was as follows:—

	Imports. £	Exports. £
1913	181,665	90,132
1914	118,507	63,424
1915	126,393	87,919
1916	194,721	130,698

The proportion of exports to imports appears to be large, but it has to be kept in mind that the exports do not all leave British Malaya, the Malay States and British North Borneo absorbing £43,914 in 1913, £26,387 in 1914, and £42,212 in 1915. Netherlands India is the other country to take a large portion of the Straits exports. China until 1915 headed the list of countries importing into the Straits Settlements, and, for the sake of

comparison, details for the three years that are available are given herewith :—

	1913. £	1914. £	1915. £
China	55,591	44,373	41,702
Germany	30,726	9,206	849
Japan	22,431	18,027	44,571
Hong-Kong	21,782	17,504	18,101
Belgium	18,760	7,721	319
United Kingdom	14,740	15,700	8,002
Netherlands India	9,592	3,753	10,238

While the demand for crockery and porcelain goods for the European population of the Malay Peninsula is likely to increase in the future, whenever war conditions allow of free movement of manufactured exports from the United Kingdom and Europe, by far the largest trade for some time will be in the cheaper and coarser goods in use amongst the Chinese and Malays. This accounts for the large share falling to China and Japan, the latter country in this, as in other branches of trade, profiting by the preoccupation of Europe in a much more serious business. It is not improbable that Japan is supplying porcelain latex cups for rubber estates in the Peninsula. To all intents and purposes the Hong-Kong statistics might be incorporated with those of China, for Hong-Kong does not manufacture much, and is merely a port of transhipment. German commercial agents were ever keen in developing trade in the cheaper classes of goods, and it is probably due to their activity that Germany was able to do so well in this region before the war. Specimens of their wares should be secured by manufacturers in this country who seek to develop their business in British possessions in the East.

The trade in earthenware other than crockery is done chiefly by China and Hong-Kong, but in 1913, when the total imports were valued at £40,716, the United Kingdom's share amounted to £8,292. The Federated Malay States take about one-half of the imported goods.—*London and China Telegraph.*

THE ELECTRIC TRAM SERVICE OF SYDNEY, NEW SOUTH WALES.

The large extent of this service, which is constructed and worked by the State Government, is accounted for by the fact that the tramways have, up to the present time, been employed, with some notable exceptions, in work ordinarily undertaken by suburban railways.

In 1879, when the system was started by a steam service, supplemented on certain steep routes by cable working, it was found so effective and economical at the time that lines were run out into distant suburbs, and the fast service supplied educated the Sydney people to keep out of the way of the cars, so that twenty miles an hour, now frequently attained by the electric service in the suburbs, leads to but few accidents. The increased service which speed gives, and the greatly lessened occupation of the streets in any given time, through that speed, forms as cheap and almost as effective accommodation as can be provided by suburban railways. There is no question that the public can be educated in this way, as the experience of Sydney shows, and if this apparently excessive speed were allowed elsewhere, with a graduated advance to it, there would be much less obstruction, without the danger which is supposed to be caused by it. It is obvious that, *ceteris paribus*, with a speed of 10 miles per hour there is twice as much space taken up as with 20 miles. The result of the fast working is that the tramcars carry nearly all the street traffic.

In 1899, the electric overhead service was initiated, and gradually the steam and cable lines have been converted. The city streets generally run from north to south, and are named after the Royal Family and the King's Ministers at the time the colony was founded—viz., Sussex, Kent, Clarence, George, Pitt, Castlereagh, and Liverpool streets, leading from the harbour to the railway station. These are intersected irregularly by cross streets, but by no means on the chess-board pattern, either as regards intervals or alignment, so much favoured by American and other Australian towns, which have been built in later times. Sydney is old-fashioned and picturesque in that respect. The tramlines follow some of these streets, branching out to the suburban districts westward, eastward, and northward after the harbour has been crossed.

The many suburban tramlines have heavy grades, especially on the north side of the harbour opposite Sydney proper, across which the traffic has to be conducted by steam ferry with large and powerful boats. For example, the tracks of the Mosman trams have to surmount 290 ft. in 4,620 ft.—that is to say, an average gradient of about 1 in 16, while the Neutral Bay line, at the same side of the harbour, rises from the water's edge at about 1 in 10 for half a mile. There are other examples of heavy grading across the waters of Sydney Harbour, but an exceptional construction occurs at one place, Darling Harbour, where a counterweight device—examples of which are in use in the United States of America—has been adopted. The ordinary type of tramway stops about 10 chains short of a steam ferry wharf. Between these two points there is a steep inclined street, the first three chains of which are on a gradient of 1 in 10·54, while the remainder is on 1 in 8·24. Here, for the purpose of connecting directly the ferry and the tramway service, and bringing the cars close to the wharf, a device has been used which may be briefly described as follows: The descending car, on coming on to the incline, is brought into contact with a buffer trolley, which it carries along in front of it. The buffer trolley is attached by a steel wire cable passed round a sheave at the top of the incline to a counter-

weight trolley running on rails in a subway under the incline, so that as the car descends the counter-weight trolley ascends, acting as a brake on the descending car. At the foot of the incline a buffer stop prevents the car from over-reaching and carrying the counter-weight too far up. On the return trip the car is started in the ordinary way by means of the electric motors, and the trolley, now at the rear end of the car, exerts a constant force upon it, due to the pull of the descending counter-weight, and thus assists the car up the hill. On arriving at the top the trolley comes to a standstill by the counter-weight arriving at the foot of the subway, where it is brought to rest by a hydraulic buffer, in which the momentum of the moving weight is absorbed.

The installation of the Sydney electric tram system, put into operation some eighteen years ago, and greatly extended from time to time, may be briefly described as under. The extent of working is from the central point of the city itself, eastward, westward, and southward, except for the suburban railway, which in part supersedes it, and northward, interrupted by the harbour already mentioned, across which the electric power is transmitted by submarine cables.

According to the latest reports, the extent of the tramway system is 150 double and 111 single miles, with passing places, operating 1,430 cars, and the cost of construction and equipment has been £7,349,866.

The annual number of tram miles run is 25,407,000, and the output of power-houses 81,591,000 units for traction purposes, chiefly generated in the form of alternating current. The passengers carried were 269,634,000.

The electrical energy is mostly generated at the power-house in Ultimo, on a site which is fairly situated with regard to obtaining coal and water for condensing purposes.

The feeder cables to the various sub-stations are of two types, underground and overhead; the former generally in bitumen casing laid under the footpath. The overhead feeder consists of hard-drawn high conductivity copper, in the form of cables, rope laid, insulated with double brading and bituminous compound.

In the principal streets Mannesmann steel poles are used with iron brackets, and cast-iron ornamental bases and fittings. In other cases the side-pole system has been adopted with span wires across the streets, and wooden poles have been also largely used, which have the advantage of providing better insulation. The timber is of the well-known Australian iron-bark, which has great strength and durability.

The permanent way has followed the universal tendency to increased weight of rails. Many of the original lines consisted of 42 lb. rails, and these have given place successively to 60 lb., 70 lb., 83 lb., and, finally, on heavy traction sections, 100 lb. per yard. In all cases the rails are of the Vignole's pattern, laid on Australian hard-wood sleepers to the standard gauge of 4 ft. 8½ in. In the suburbs they are laid in macadam with basalt ballast, but on most of the city lines the rails are carried by sleepers in concrete. The almost universal practice of laying the rails butt-jointed is used. A special type of construction has been laid from the railway station to the harbour, which is the line of greatest traffic. This is with rigid joints, and with machined fish-plates, the rails being electrically connected by strips of thin copper, squeezed between the fish-plate and the web and flange of the rail. Thermit welding also has been used.

The system of city and suburban electrical railways, supplementing but not superseding the tramlines, through the central and outlying parts of Sydney, has been authorised, and operations have already been begun. The description of these railways will be found in the *Engineer* of August 17th last.

The reason for touching on these matters in an article on tramways is the fact that, included in the above estimate and plans, is an arrangement, to be found nowhere else, so far as the present writer is aware, of underground electric tramlines. These are intended to supplement the existing tramways overhead on the surface of the street, which are unable to deal with the traffic themselves. The street so dealt with might be represented by the figure of a closed pair of tongs splaying out at the extremities, giving entry to or exit from two lines of city streets mainly bearing north and south. The two splays show approaches to the suburbs, and are arranged to rejoin the two tracks overhead on the same vertical plane, without breaking continuity, by diversions laterally in both directions, by grading up to their level, and by crossing and points.

These underground tramways, 4½ continuous miles in all, run beneath busy shops and offices. The stopping places are at intervals with openings to admit of entry and exit to the street above, the tunnels or covered ways being lined with glazed tiles, and lit by electricity. The cars would run at a still greater speed than they do on the surface, having no traffic to avoid.

These tramways, together with the proposed electric railways, besides the two cantilever harbour railway bridges, which they include, as well as roadways and motorways 170 ft. high above water-level, to be constructed by the State Government, will cost 20 millions, a large outlay for a city of the size of Sydney.

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

Industrial Councils.—It is palpable that nobody is as clear as he would like to be about the scope and functions of the joint industrial councils proposed by the Whitley Report. The

plea that if such councils were formed many things could be done by them is doubtless sound, but it is much too vague to be satisfying. As an institution, and apart from the particular question of what the councils shall touch and what leave alone, there is hardly anything to be urged against them. But down in their minds employers feel that if the councils entrench upon employers' prerogatives they will not be popular with their own side, and they fear that, unless the councils do take control in a larger measure out of the hands of the proprietors of the business, they will not be satisfactory to the other side. The authors of the suggestion to establish councils would doubtless say it is for the parties concerned to settle between themselves the limits of the joint jurisdiction, and this reply may seem fairer to others than to certain members of the textile industry.

Cotton Trade Organisation.—The cotton trade already has, if not the identical councils of the Report, at least a colourable substitute for them, and yet the state of that industry is not perfect. The union "shop clubs" of the mill do not contain representatives of the employers, but the clubs ordinarily negotiate with such representatives before proceeding to extremities. The district conciliation boards and the joint meetings of federations of employers and operatives are not effectively very different from the proposed district and national councils. These bodies do not always compose their differences amicably; with a monotonous regularity they find it necessary to refer their troubles to some third authority for settlement. The cotton trade mechanism is sometimes looked upon as a model, but one of the most thoughtful of cotton manufacturers ejaculated "God save them!" for the edification of those who think to abolish industrial unrest by duplicating the cotton trade organisation. It may be inferred that something is lacking in the latter, and whether this is merely the final touch of technical perfection in formal arrangements for dealing with causes of dispute, or something much more deep-seated, can be left an open question.

Grounds of Contention.—By universal consent mutual confidence is the true bond of industrial peace, and it does not automatically follow that this confidence will increase with the multiplication of opportunities for interference with what the owners and managers of private businesses conceive to be the only right way of settling the point at issue. In their essence, all industrial disputes, other than those arising between sections of workers, are rebellions against the sovereign power of the employer. Whether the question is purely one of rates of wages or concerns the arrangement of duties, the selection of raw material or the decision as to the class of goods to be made, is all one in the end; and it is worth observing that the cotton industry has known disputes upon all of these grounds. The title of workpeople to interfere in some of these respects is fiercely resented, although in practice there is not one upon which their feelings have not to be consulted, tacitly or otherwise. The temper that would brook no interference has softened, but it cannot be professed that employers are anything like ready to concede to workpeople, who may be avaricious as well as ignorant, a power co-equal with their own in matters upon which the fate of the whole undertaking depends.

Mill Committees.—Mr. H. P. Greg, whose ejaculation has already been quoted, put the case with striking fairness in the discussion promoted by the Textile Institute. It was impossible, he reasoned, for employers to make fools of themselves and their workmen by granting a power that the workers had not been trained to exercise, but not impossible to train the workpeople to exercise that power and introduce them gradually to its use. A less liberal view will prevail in many quarters, but it is upon these principles that joint control can be made a success, and it could be wished that those who think with him would draft a constitution defining the share of the wage-earner in the control. The idea that it is not so much large organisations as domestic organisation that is needed is notable. The bottom-range councils, the mill joint committees, are the ones to which Mr. Greg assigns first importance, and this estimate can hardly be wrong. It is, however, requisite that the general scope of these institutions should be defined, and it does not follow that a mill committee composed in exactly equal quantities of representatives of the workpeople and of the proprietors is ideal for the occasion.

Excess Profits.—Envious or unfavourable comment has been evoked by the publication of the profits of certain textile undertakings. The profits of the wholesale drapery houses have come in for especial attention, although it is difficult to see how their excess profits could be avoided, given merely ordinary diligence in affairs. Markets, for one cause and another, have been consistently rising ones, and those who have bought and waited the long time demanded for delivery have found their goods consistently worth more than at the time of purchase without conscious guilt upon their own part. The profits are to be regarded as the effect of the rise and not its cause, as has sometimes been assumed. There is, at any rate, no suggestion that the Government fails to take its four-fifths of the unwonted increment, and the argument that it is in some way discreditable to receive

the balance of the gains is difficult to follow. Onlookers have seen the same merchants and manufacturers doing badly without exhibiting so much as a sympathetic twinge, and if experience is any guide a difficult time awaits the now fortunate concerns when the tide goes back. There was a painful time, for example, in the eighties.

Camouflaged Cotton.—The military idiom makes some headway in textile affairs. Any business killed by official action is, in the language of the hour, "torpedoed." Inferior material disguised as something other than itself is "camouflaged," and in America they take the camouflage of cotton and waste wool with intense seriousness. Stern remonstrances have been addressed to those who cultivate longings for all-wool, and some, apparently, would have the very name forbidden. British consumers, also, have been told that they must prepare to receive cotton in their woollens, and this they might the more willingly do were it generally understood that the cotton is there for their advantage. The objection to cotton is mainly indirect, arising from its associations. The best wool needs no cotton, and the presence of it is one sign that the woollen is not of the best, and not able to stand by itself. The consumer cannot picture to himself what the same goods would be without the foreign element of support, but normally he would find the value worse.

OBITUARY.

COLONEL FREDERICK FIREBRACE, R.E.—Intimation has been received of the death of Colonel Frederick Firebrace, which took place on September 21st.

He was born in 1840, and obtained his commission in the Royal Engineers in 1861. He proceeded to India in 1865, joining the Public Works Department as Assistant Engineer, North-West Provinces. After serving as Assistant Principal of the Thomason Civil Engineering College, Roorkhee, he entered the Railway Department of the Government of India, and was Under-Secretary to the Government for seven years. His most important work was performed when he was Consulting Engineer for Railways, Bombay.

In 1894 he retired from the Service, and became managing director of the Great Indian Peninsula Railway, and chairman of the company in 1911. He was also a director of the Grand Trunk and Grand Trunk Pacific Railways of Canada.

Colonel Firebrace was elected a member of the Royal Society of Arts in 1893.

THOMAS TILLYER WHIPHAM, M.D., F.R.C.P.—Dr. Thomas Tillyer Whipham died on the 3rd inst. at Hatherleigh, Devon, at the age of seventy-eight. He was educated at Rugby and Oriel College, Oxford, where he graduated M.D. in 1888. He was for many years closely associated with St. George's Hospital, having held the posts of Demonstrator in Anatomy, Curator of the Museum, Lecturer on Botany, Pathology, and Medicine, Assistant Physician and Physician. He was also Examiner in Medicine for the University of Oxford, and for the Royal Colleges of Physicians and Surgeons in England. He contributed a number of articles to the *Lancet* and other medical journals.

Dr. Whipham joined the Royal Society of Arts in 1900.

GENERAL NOTES.

THE "ENGLISHWOMAN" EXHIBITION OF ARTS AND HANDICRAFTS.—This exhibition will be opened at the Central Hall, Westminster, on Wednesday, November 14th, at 3 p.m., by H.R.H. Princess Patricia. It will remain open until November 24th. This is the seventh year that the exhibition has been held. Upwards of fifty industries will be represented by well-known craft workers. The exhibits will include weaving, pottery, glasswork, toys, model buildings (including a model of the Royal Free Hospital), model boats and aeroplanes, hospital requisites, etc. A special feature will be an exhibit by sailors of the First Naval Division interned in Holland.

MEDICINE AND THE MILITARY DEATH-RATE.—Dr. Woods Hutchinson, in a Chadwick Lecture recently delivered at the Robert Barnes Hall, Wimpole Street, gave some remarkable figures relating to the influence of medicine upon the military death rate. By wiping out epidemics the doctor, he said, had actually kept the death-rate among the civil populations of the Allied countries as low as, and in some cases lower than, it was before the war. By redoubling the care and protection of young children almost as many additional young lives had been saved as adult ones had been on the field of battle; so that the populations of the Allied countries were practically holding their own. His control over wound-infections was so masterly, that of the wounded who survived six hours 90 per cent. recovered, of those who reached the field hospitals 95 per cent. recovered, and of those who arrived at the base hospitals 98 per cent. got well. Anæsthetics and antiseptics had not only enormously diminished pain and agony, but had made amputations rarer and grave cripplings fewer than ever before in war history. Barely 5 per cent. of the wounded were crippled or permanently disabled. From the statistics made public there was good reason to believe that the death-rate of this war, in spite of the colossal increase in instruments and engines of scientific slaughter, did not much exceed 5 per cent. per annum.

Federated Malay States Railways.—The Federated Malay States Government proposes to construct deep-water wharves at Prai for the use of ocean-going ships, and it is anticipated that as a result there will be a considerable increase of trade between Penang and Bangkok, the present railway connection shortening the distance from Bangkok to Europe by something like five days. It will also shorten the European mail service to Bangkok by causing the mails to be discharged at Penang instead of at Singapore, whence they will be forwarded by rail to Bangkok. Tourists from Singapore and Penang to Bangkok will further have the opportunity of going by train through an interesting and comparatively unknown country and returning by water to Singapore to continue their journey eastward.

The Indian Tanning Industry.—Speaking in the Imperial Legislative Council on September 5th, the Viceroy, Lord Chelmsford, said that in order to meet the War Office demand for leather tanners in India, orders have now been given on a scale that has encouraged them to reform their methods, and by having to work regularly to a rigid standard of high quality a striking improvement has already taken place. The Munitions Board, with the generous consent of a group of Central Indian States, has taken over the tannery at Maihar to test new tan stuffs, new combinations of known materials, new processes, and the manufacture of concentrated tan extracts. Those results which on an experimental scale appear to be successful are being tested on a commercial scale at the Allahabad tannery, recently purchased for the purpose. The results, as they become established, will be published for the benefit of tanners in other parts of India. A certain number of students are already being entertained as apprentices, and it is hoped later on to develop this side of the work by the formation at Allahabad of an institute in which the scientific aspects of tanning will be taught in conjunction with practical work on a commercial scale in the tannery itself.

Paper from Spent Bark.—The *Leather World* draws attention to a new use for spent wattle bark. It appears that the Imperial Institute authorities are highly satisfied with the result of tests, undertaken in the Institute laboratories, concerning the suitability of Natal wattle bark (after it has been discarded by the tanners) for the manufacture of paper. These tests, which were on a small scale, demonstrated that a good quality brown paper can be manufactured from the spent bark. This paper bleaches readily to a cream tint, and has been pronounced eminently suitable for newspaper purposes, and, with further treatment, may make serviceable writing paper. The Institute authorities have interested several large paper-mills in these discoveries, and large-scale tests are now proceeding to confirm the experiments on a commercial basis.

MEETINGS FOR THE ENSUING WEEK.

Monday, November 12...Surveyors' Institution, 12, Great George-street, S.W., 5 p.m. Address by the President.

Geographical Society, Burlington-gardens, W., 8.30 p.m. Paper by the President, "Some Geographical War Problems in the Near East."

Tuesday, November 13...Swiney Lecture, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.30 p.m. Professor J. S. Flett, "The Mineral Resources of the British Empire." (Lecture I.)

University of London, University College, W.C., 5 p.m. Professor S. D. Adshead, "Housing Problems after the War." (Lecture II.)

Asiatic Society, 22, Albemarle-street, W., 4 p.m. Lieut.-Colonel A. C. Yate, "Jang Nafusk" and "The Red Thread of Honour."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 6.30 p.m. Mr. L. A. Shuffrey, "Chateaux of the Loire Valley."

Wednesday, November 14...Aeronautical Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m.

Biblical Archæology, Society of, 37, Great Russell-street, W.C., 4.30 p.m. Mr. A. Blackman, "Sacramental Ideas in Ancient Egypt."

Automobile Engineers, Institution of, in the Physics Lecture Room, University College, W.C., 8 p.m. Dr. E. G. Coker, "Photo Elasticity for Engineers."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Colonel Sir Robert Jones, "The Problem of the Disabled."

Chadwick Public Lecture, 1, Wimpole-street, W., 3.30 p.m. Dr. W. Hutchinson, "The Part of Hygiene in the European War." (Lecture III.)

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor Sir Henry Newbolt, "Maurice Hewlett's 'The Song of the Plow.'"

Thursday, November 15...Swiney Lecture, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.30 p.m. Professor J. S. Flett, "The Mineral Resources of the British Empire." (Lecture II.)

Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, W., 5 p.m.

Chemical Society, Burlington House, W., 8.30 p.m.

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Professor M. V. Trofimov, "A Century of Political Life in Russia."

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, Piccadilly, W., 5.30 p.m. 1. Mr. S. J. Truscott, "Slime Treatment on Cornish Frames: with particular reference to the effect of surface." 2. Mr. H. A. Lewis, "Comparative Concentration Tests on Wood and Fluted Glass Surfaces at Porco, Bolivia."

China Society, Caxton Hall, Westminster, S.W., 3.30 p.m. Mr. W. McLeish, "Life in an Outport: Reminiscences of Tientsin."

Friday, November 16...Swiney Lecture, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.30 p.m. Professor J. S. Flett, "The Mineral Resources of the British Empire." (Lecture III.)

Mechanical Engineers, Institution of, Storey's-gate, Westminster, S.W., 6 p.m. Mr. A. W. Purchas, "Some Notes on Air Lift Pumping."

Saturday, November 17...Automobile Engineers, Institution of (Scottish Section), Technical College, Glasgow. Mr. H. P. Saunderson, "Tractors."

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FRIDAY, NOVEMBER 16, 1917.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

ALBERT MEDAL.

The following letter from Mr. Orville Wright has been received by His Royal Highness the Duke of Connaught and Strathearn, K.G., President of the Society:—

HIS ROYAL HIGHNESS THE DUKE OF CONNAUGHT.

YOUR ROYAL HIGHNESS,

I have the pleasure of acknowledging the receipt of Your Royal Highness's letter and the Albert Medal of the Royal Society of Arts, which were forwarded to me through the British Ambassador at Washington.

I wish to express my appreciation of the honor conferred upon me by the Royal Society of Arts as a recognition of the work of my brother Wilbur and myself towards the solution of the problem of flight. I appreciate with the utmost gratification the honor of being placed by your Society among such men as those to whom this coveted medal has been awarded in years past.

With expressions of the most sincere regards,

I am, respectfully yours,

(Signed) ORVILLE WRIGHT.

Dayton, Ohio, U.S.A.,
eptember 25th, 1917.

ARRANGEMENTS FOR THE SESSION.

The Opening Meeting of the One Hundred and Sixty-Fourth Session will be held at 4.30 p.m. on Wednesday, November 21st, when an address will be delivered by ALAN A. CAMPBELL SWINTON, F.R.S., Chairman of the Council. The subject of the address will be "Science and its Functions."

The following arrangements have been made for the meetings before Christmas:—

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

NOVEMBER 28.—G. HOLT THOMAS, Chairman, Aircraft Manufacturing Company, "Aerial Transport after the War."

DECEMBER 5.—SIR DUGALD CLERK, K.B.E., D.Sc., F.R.S., "Discovery and Invention" (Inaugural "Trueman Wood" Lecture). ALAN A. CAMPBELL SWINTON, F.R.S., Chairman of the Council, will preside.

DECEMBER 12.—LORD CHARNWOOD, "Technical Training for Disabled Soldiers and Sailors."

DECEMBER 19.—PROFESSOR J. WEMYSS ANDERSON, M.Inst.C.E., M.I.Mech.E., Dean of the Faculty of Engineering and Lecturer in Refrigeration, University of Liverpool, "The Cold Storage Industry." The HON. SIR THOMAS MACKENZIE, K.C.M.G., High Commissioner for New Zealand, will preside.

COLONIAL SECTION.

Monday afternoon, at 4.30 p.m.:—

NOVEMBER 26.—LIEUT.-COLONEL THE HON. SIR JOHN MCCALL, M.D., LL.D., Agent-General for Tasmania, "Land Settlement within the Empire." The RIGHT HON. WALTER H. LONG, LL.D., F.R.S., M.P., Secretary of State for the Colonies, will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

DECEMBER 13.—D. T. CHADWICK, I.C.S., "The Trade of India with Russia, France, and Italy." The RIGHT HON. LORD ISLINGTON, G.C.M.G., D.S.O., Under-Secretary of State for India, will preside.

CANTOR LECTURES.

Monday afternoons, at 4.30 p.m.:—

H. C. H. CARPENTER, M.A., Ph.D., M.Inst. M.M., A.R.S.M., Professor of Metallurgy, Imperial College of Science and Technology, "Progress in the Metallurgy of Copper." Three Lectures.

December 3, 10, 17.

The arrangements for the meetings after Christmas were announced last week.

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

MEMORIALS AND MONUMENTS.

By Lawrence Weaver, F.S.A.

Lecture III.—Delivered March 19th, 1917.

The aspects of memorial art which I shall attempt to deal with to-day are so large, and are necessarily related to so many other artistic and even engineering problems, that I can do no more than discuss and illustrate a few general principles. A course of twenty lectures would be needed to explore the many possibilities of monuments which are also central features of town-planning schemes.

Equestrian Figures.

I will begin with the monument most commonly used to commemorate a great soldier—the equestrian figure. The development of the type has been affected more perhaps than any other by the growth of technical processes and of craftsmen's skill. Lord Crawford, whose book "The Evolution of Italian Sculpture" has put all students in his debt, tells me that some day he hopes to trace the treatment of the sculptured horse from the most primitive type, in which the body is supported by four legs and three stays, through the gradual discarding of stays up to the rearing horse in bronze, in which the toughness and tensile strength of the metal enables the great weight of the horse with its rider to be supported on the two hind legs. It is the consideration of points like this which shows how much questions of style depend ultimately on technical possibilities, and that is why Robert Louis Stevenson, writing of literary workmanship, made an observation which is abundantly true of any art: "Bow your head over technique. Think of technique when you rise and when you go to bed. Forget purpose in the meanwhile; get to love technical processes — to glory in technical successes; get to see the world entirely through technical spectacles. . . . Then when you have anything to say, the language will be apt and copious."

In equestrian figures, however, the very perfection of technical skill has proved a snare from the point of view of design. An undue representation of movement destroys that sense of repose which should be characteristic of sculpture.

Perhaps the three finest equestrian figures in the world are the Can Grande—in which, however, it is the rider who chiefly rivets our attention—Donatello's Gattamelata at Padua, and the Bartolommeo Colleoni at Venice, begun by Andrea Verrochio about 1483—he was doubtless wholly responsible for the modelling -and cast and placed on its pedestal by Leopardi in 1493. Both subjects were mighty men-at-arms, Condottieri, and, despite their violence of life, there is a majestic repose in both subjects, especially in Donatello's handling, which is altogether satisfying. At the other end of the scale are the Joan of Arc at Chinon, galloping her horse so furiously that only its two forefeet touch the ground and its hindquarters stream behind in the air. The way the almost horizontal forelegs are supported and the figures stricken down by the triumphant Maid, is a triumph of invention and skill; but the restlessness of the composition makes it to me far less attractive than the quiescence of the fine gilt statue of the Maid in Paris, which looks across the Rue de Rivoli.

By the same token, the horse of Prince Amadeus of Savoy at Turin, rearing on his hind legs, pays for its vitality by a sense of insecurity. A happy medium in action is seen in Dubois' Joan of Arc at Rheims, and there is a splendid mediaeval quality in Fremiet's treatment of the same subject, exhibited at the Salon in 1889, but not, as far as I know, set up in a public place.

Many of our seventeenth and eighteenth century equestrian statues in England are based more or less closely on the oft-reproduced Marcus Aurelius; but Le Sueur's Charles the First at Charing Cross is a superb piece of personal work, and the finest statue in its kind that we have. Its base, designed by Wren, and carved, not by Grinling Gibbons, but by Joshua Marshall, when it was set up again after being in hiding during the Commonwealth, is a delightful composition, and makes some of the very severely plain and architectural pedestals used in our own time look gaunt and uninteresting. If the architectural treatment is rich, as in the Colleoni monument, the lack or slight employment of sculptured ornament is not noticeable, but scenes in low relief or subsidiary figures in the round give a richness to the whole composition which may be very valuable. Examples of this are the Garibaldi at Milan and the Lord Roberts memorial, modelled for Glasgow by the late Harry Bates, in which, by the way, the treatment of the horse shows a happy combination of restraint and movement.

Needless to say, the precise treatment most fitting for the pedestal of an equestrian or any other figure or group of figures should be based on the architectural setting of the site. For example, the George the Fourth in Trafalgar Square has a pedestal which would look tame if set by itself in an open space, but it accords admirably with the general design of the square.

The supreme form of equestrian pedestal is to be seen in the Wellington monument, where the genius of Alfred Stevens welded into an indissoluble whole a tomb and an equestrian figure by an architectural *tour de force* which remains unique. It is essential that the figure and pedestal should be one thing, not two. This unity is well shown in Thorwaldsen's Schiller monument at Stuttgart.

Group Memorials.

For the commemoration of a group of men, such as the old boys of a public school or the officers and men of a regiment who have given up their lives in war, an infinite choice of monuments lies open. The major part of the memorial will often be, as I indicated in my first lecture, to some extent utilitarian, and very commonly a building; but if an independent open-air monument is desired, there are still many forms, such as the column—*e.g.* the Crimean memorial to old Westminster boys outside Dean's Yard; the modern variant of the town or village cross—*e.g.* the late G. F. Bodley's South African memorial to men of Yorkshire regiments; or an obelisk with wing walls—*e.g.* Mr. Schultz Weir's memorial to R.A.M.C. men (South Africa) at Aldershot; or without wing walls but with an elaborated pedestal—*e.g.* Mr. Reginald Blomfield's Haileybury memorial (South Africa). The obelisk is one of those eternal forms, at once aspiring and reposeful, which seem especially fitted for a memorial monument. It is, moreover, an element which combines very freely with a great variety of architectural forms, and thus falls readily into the general scheme of treatment which the site or surroundings may suggest. From ancient Egypt to the Thames Embankment is a far cry; but what could look more natural than Cleopatra's Needle with its flanking ornaments?

The R.A.M.C. monument, with its emblematic figures, by Sir William Goscombe John, R.A., gives convenient hospitality to sixteen bronze panels bearing the names of those who died in South Africa, and this catalogue is provided without belittling the broad lines of the monument itself. At Haileybury Mr. Blomfield has given richness and a Roman flavour to the obelisk by bronze plates bearing the names of the sixteen chief battles in South Africa.

Nor must I forget the noble inscriptions drafted by Dr. Montagu Butler, of Trinity, Cambridge: "Haileyburiensibus in Africa pro patria mortuis Haileyburia filiorum memor," and

"Sta, puer, et revocans quos abstulit Africa fratres,
Vivere pro patria disce morique tua"

—a behest which Haileybury boys have splendidly obeyed on the stricken field these thirty-one months past.

Two other monuments to individuals, which are yet of very suitable form for group memorials, are the Florence Nightingale monument at Liverpool, designed in the Neo-Grec manner by Messrs. Willink and Thicknesse, architects, and with sculpture by Mr. C. J. Allen, and the obelisk to Onslow Ford, designed by Mr. John W. Simpson, in Grove End Road, St. John's Wood. The figure is a replica of one by Onslow Ford himself on the Shelley monument at Oxford, and on the other side of the monument is a bust of the artist by Mr. A. C. Lucchesi.

The War Memorial.

We may pause here to consider what should be the emotional and intellectual appeal of the larger kind of war memorial, such as will be set up by great cities and nations when the present conflict is ended. We hope and believe that we shall have victory to commemorate—a triumph of right over wrong, of liberty over oppression. We shall in any case be symbolising our passionate pride in the deathless courage of our noble dead—we shall be celebrating by imperishable forms achievements both by the dead and the living, which in their magnitude and universal character dwarf anything that the records of national strivings can show. Whatever the outcome of the war we shall have infinite ground for pride of race, as indeed will all the belligerents. The war has brought to light many hidden powers of wickedness and cruelty, many offences committed in the name of Necessity which may well cause the blood of innocent victims to cry out from the ground to Heaven; but it has also revealed a wealth of hardiness, of unquenchable patriotism, and of unlimited self-sacrifice such as the artist may well despair of revealing in the concrete form of a monument. The monumental courage of the nations may be expressed by such conventions as the superb Lion of Belfort, a colossal symbol carved out of the living rock. But if and when the Allies have achieved that deliverance from the night-

mare of a world-wide military domination for which they are pouring out their life's blood, it is to be hoped that their memorials will not be conceived in the spirit of cruel and lustful pride which marked Germany's commemoration of her victory over France in 1870. We can very readily compare the Latin and Teutonic ideals, for they are seen sharply contrasted in the French monuments of the Napoleonic Age, and those that followed 1870, on the one hand, and in the German memorials of the Age of Bismarck on the other. The French had the purpose to typify the triumph of victory over death, the courage of the nation even in failure, and that pleasure in the civic as well as military virtues which have made France one of the leaders in true civilisation and the art of living. Their monuments are almost invariably Latin in form as well as in spirit, and the older examples especially are refined and subtle in their appeal, while lacking nothing in strength and dignity. Even when they are somewhat over-full of gesture, as in the Gambetta monument at Paris, they are instinct with humanity as the Latin and Anglo-Saxon understand it and not with the brutal cult of the Nietzschean super-man revealed in all its horrible inhumanity by German monumental art during the last forty years. Desiring, it would seem, to prove their freedom from Latin influences, and seeking an expression of their new Kultur which might be called truly German, they turned their backs alike on classic humanism and on Christian ideals, and evolved a monstrous mode in architecture and sculpture alike. Their explanation of the crude and brutal forms, which they mistook for strength, was that they represented the savagery of Odin and Thor, fit gods to preside over a policy of oppression and conquest.

The Bismarck monument at Hamburg has this one supreme merit—it represents perfectly the character of the man commemorated, the character of the nation which idolised the exponent of the blood-and-iron policy, and the character of the artists who translated these characteristics into stone. To the extent that it is perfectly representative, the Bismarck monument is good art, but in essence it is a return to barbarism.

The War Memorial at Leipzig is an even more complete revelation, and the illustration I show with a Zeppelin and a warplane hovering over its brutal mass shows very exactly that even before the war these weapons which they have used so ruthlessly and with so little real success were their own essential symbols of war. Carved in immense letters on the base are the words: "Gott mit uns," but the savage cruelty of the sculptured accessories and their uncouth parodies of human forms show what manner of God they seek to be with them. The German Professor Hossens' design for a national memorial to Bismarck is less obviously barbarous in intent, but the distance the Teutonic mind has travelled since it conceived its scheme of domination may be judged by a comparison of this with the Temple to Bavaria at Munich and the Valhalla at Regensburg, both dignified buildings in a classical manner. The Valhalla was built in 1830, and commemorates Teutonic statesmen, soldiers, poets and musicians. It is in the spirit of the old Germany that loved the old classical culture, on which the modern men of blood and iron have turned their backs. Compared with them, what could be more gross than the German design for a monument in which an eagle, truly an unclean harpy bird, perches on the model of a fort cupola?—this is the militarist spirit unashamed. Equally grotesque, but in another manner, are the tall formless monument which might come out of some nightmare scene painted for a drama of the Nibelungs, and the hobgoblin monument perched on a hill top and approached by an endless flight of steps.

It is a refreshment to turn from such meaningless exercises in a brutal and forced originality to the magnificent sanity of such a monument as the Arc de Triomphe, Paris. Begun in 1809 to the design of Chalgrin, it marks the wonderful artistic *flair* of the First Napoleon, who insisted on the omission of applied columns from the face of the arch. Five other architects were concerned in turn with various modifications of the original design, and the arch was not finished until 1826. It remains one of the finest, if not the finest, of war memorials, and owes much to Rude's magnificent sculptured group. Perhaps the Triumphal Arch is the most impressive form a war memorial can take, though much is to be said for the great column. The Arc de Triomphe derives at last from Roman models, such as the Arch of Titus and the Arch of Constantine; but one feels that in the case of the former especially the application of the Orders as a decorative feature is not wholly successful. In the Arch of Constantine they play a more reasonable and organic part in the complete composition. The Washington Arch at New York, designed by McKim, is based quite frankly on the Arc de Triomphe, but with such variations as to mark it for an original work. It is, indeed,

a happy instance of a fine power of personal design working along traditional lines. Our own screen at Hyde Park Corner, and the arch on Constitution Hill, are examples of the same outlook on monumental design. Decimus Burton who designed them, had provided in his early design for the arch that it should be surmounted by a quadriga, perhaps, rather small in scale. The quadriga erected a few years ago on the top of the arch, and modelled by Captain Adrian Jones, is so much too large that the arch seems to have abdicated its own character and to have taken on a duty which makes it practically a pedestal. Even as it is I personally like it for its attractive skyline, but Burton's scheme has been greatly changed.

The arch, as it now stands, defies the principle of the desired unity between the sculptured group and its pedestal, which is seen so finely in the Moncey monument in the Place de Clichy, Paris (sculptor, Doublemard). The architect, Guillaume, has given to this military memorial a fine civic quality by employing battlements, a civic emblem, amongst the decorations of the pedestal.

Before passing from the contrast between the classic spirit and the sham and brutal archaism of modern Germany, a word must be said of our own monuments of the Gothic Revival. The Albert Memorial has some good points about it, but as a composition it is restless and unpleasant. If it be compared with "Greek" Thompson's design for Albert's memorial (unduly grandiose, it is true, for its subject), the difference between the spirit of the two will be sufficiently apparent. The austere repose of that great man's art is more and more being realised. The same contrast is to be noted between the Gothic monument to Sir Walter Scott in Princes Street, Edinburgh, and the Burns Memorial at Edinburgh, which takes the form of a Choragic monument. But with the Scott monument there was a special reasonableness in adopting the mediæval manner, for the man was the especial interpreter of mediæval life and manners and of the romantic spirit.

Memorial columns take their beginning with that of Trajan's Forum, on which the original statue of the victorious emperor has been replaced by one of St. Peter. The narrative sculptures are of extraordinary interest, and Mrs. Strong's book, "Roman Sculpture," should be studied for their elucidation. I referred in my last lecture to the especial value and beauty of the lettering of the inscription. We are fortunate in possessing a model of the column at South Kensington.

The column in the Place Vendôme, Paris, with its narrative sculpture spirally disposed, is directly derived from Trajan's. More personal in its design is the superb bronze column of July at Paris, designed by Duc, to which the broad base gives an added dignity. The column of the Grand Army at Boulogne has a special value, by reason of the broad treatment of the site and the comparative value given to the column itself by the low flanking buildings. As a piece of site-planning, nothing could be more interesting than our own Duke of York's column at the foot of Waterloo Place. Nelson's Column is rather overwhelming in Trafalgar Square, and Sir Charles Barry, who designed the Square, protested against its erection; but I agree with Professor Adshead that the proposals to tinker with the column and Square should be treated with coldness, and that any money and æsthetic energy which London and the nation can provide for great memorial and town-planning schemes will be best employed on justifying to-day's art by new work rather than by pulling down what our forefathers did.

For naval memorials the Romans invented the Rostral Column, of which two fine examples —designed by Poitevin, a local architect, in 1829 —are at Bordeaux. They are also adorned with anchors, and surmounted by figures of Commerce and Navigation. The bases of these figures were fitted to serve as beacon lights for the harbour. The *motif* of the Rostral Column was well employed for a smaller monument by Flaxman, for a memorial to Captains Mosse and Riou. The model is now in the Soane Museum.

Very noble are two great columns in America, designed by McKim. That erected at West Point is set on a fine base surrounded by battle emblems, and is surmounted by a winged Victory. The Prison Ship Martyr's Memorial at Brooklyn is placed magnificently at the head of a triple flight of steps, and is of a telling simplicity. America is fortunate in having gone to France and not to Germany for the spirit of her monuments. Whatever criticism may be directed to the detail of Bertholdi's Statue of Liberty in New York Harbour, it has been a heartening symbol to meet the eyes of millions of immigrants seeking a new and freer life in a new continent.

But the war memorial with the finest intent of any set up we owe to Latin America. I refer to the Christ of the Andes. After the last war between Argentina and Chile, a colossal figure

of our Lord was set up at the head of a great valley beneath the noblest peaks of the Andes, with the following legend: "Sooner shall these mountains crumble to dust than Argentines and Chilians break the peace which at the feet of Christ the Redeemer they have sworn to maintain."

This superb inscription is instinct with a feeling which we may hope, but I fear in vain, may characterise the emotions of Europe after the present conflict is ended. I should like to think of other noble figures of the Prince of Peace brooding over the blood-soaked fields of Belgium, France, and Russia, tokens of a new devotion to Christian principles brought forth in the travail of war. If, and only if, the designers of the national memorials of the future are alive to the spiritual ideals for which the Allies are pouring out their blood and treasure will the monuments of the future be worthy in their artistic and spiritual appeal. I am sorry that I cannot show you a slide of the great pillar surmounted by a figure of Christ which Mr. Eric Gill has designed as a suggested memorial to the men of the Overseas Forces. It is much to be hoped that this splendid symbol of the Faith will take shape, and that the column so gloriously crowned will tower above all others. And upon its base might be carved the line from the American Battle Hymn, but altered to make it a record rather than an exhortation: "As He died to make men holy, they have died to make men free."

Site and Town-planning and Monuments.

The setting of monuments in public places involves problems of the highest artistic importance. It is not enough to contrive a group of sculpture on a pedestal and to place it on a little desert of paving. Its relation to the neighbouring buildings, its significance as a focal point, its value as closing a vista on some important axial line—all these and many other questions demand the greatest skill that architects can bring to bear on them. Moreover, they call for generous financial provision by Government or municipality, so that the monumental scheme may not be wrecked by lack of the necessary street improvements. In more modest schemes in cities the effective grouping of statues instead of scattering them about haphazard needs consideration. A good effort in that direction is shown by the re-arrangement at the bottom of Waterloo Place. The Crimean memorial, an example of Victorian art at its best, was moved a little north and the old statue of Herbert and the new figure of Florence Nightingale grouped with it. We may regret the design of the two pedestals, but the general scheme is good.

Sackville Street, Dublin, is a good example of town-planning, with Wilkins' fine Nelson column at the end and the O'Connell statue in the middle distance. Very notable, too, is St. Gaudens' monument to Parnell, in which the statue of the uncrowned king of Ireland stands against a great monolith, altogether a very notable conception.

The Wilberforce column at Hull is a fine example of the relation of such a monument to public buildings, and indeed my photograph suggests Venice rather than an English seaport.

The Shaw monument at Boston, U.S.A., a Civil War memorial designed by McKim, is an admirable example of adjustment of the monument itself to the needs of road-planning on two levels.

Town-planning schemes in which a great architectural feature serves as the memorial monument are likely to grow in favour. A historical example is the remodelling of Trieste, which marks the Napoleonic *régime*.

Our own Waterloo Bridge, by John Rennie, will, we trust, prove the precursor of a magnificent Charing Cross Bridge with associated monuments commemorating such great figures of the war as Kitchener. It will be a difficult problem, owing to the variety of levels, and the great divergence of opinion as to the best line of approach, but already many acute minds are at work on it, and we must look forward to a design which will symbolise the majesty of British sacrifice and strength, as Rennie's Waterloo Bridge does most justly. It will need to be in an austere mould rather than in that somewhat lightsome manner which our French friends employed for the Pont Alexandre III. Happily no public building of distinction or history stands in the way of adopting the best scheme which London traffic demands and British art can contrive. We want something of the grandeur of Dance's scheme (now shown by Daniel's drawing) for a great Port of London with two bridges. Dance proposed to match Wren's Monument of the Fire with a naval column.

Conscious as I am of the sketchy fashion in which I have dealt with my very large subject, I have at least tried to lay stress on a few important points. Let me recapitulate some of them. Our monuments must be entrusted to the ablest artists this Kingdom and Empire can produce, and in the case of even the smallest

memorials we must seek the artist and not the tradesman. Our greater monuments should be conceived in that large classical spirit which, as history shows, can express so perfectly the high national endeavour and superb qualities of courage and sacrifice which the Allies are showing in their defence of the world's liberties against a nightmare of aggression and cruelty. Both in their design and their inscriptions our war memorials should reveal a devotion to the ideals of national righteousness rather than a mere exultation in military prowess and in the material resources which, as we hope, will aid our march to final victory.

Mors janua vitæ. It will be the function of art as well as statesmanship to show that the death of uncounted thousands for righteousness sake should be the gate to a new national life, purged of hesitations and follies.

Our memorial art should be proud indeed, but thankful and austere and pitiful, in remembrance of the Preacher's word that it is righteousness which exalteth a nation. Its significance should be lofty, rejecting such crude realisms as the statue of a dying soldier clad in service kit, but relying on symbolisms which will tell to the generations following the sacrifices of this Imperial race in the fight for right and for the great truths and great liberties which we are in arms to defend.

THE GERMAN BEE-KEEPING INDUSTRY.

The German bee-keeping industry dates back to the beginning of the thirteenth century, and at that time was especially important around the city of Nuremberg, where there were large forests and tracts of heather and cranberry bushes which were considered ideal for bee-keeping. During the thirteenth century the "Imperial Bee Garden" was established at Erlangen.

The gathering of honey was at first confined wholly to the wild product found in the forests, but as the industry gained in importance hives of various kinds were constructed and put into use, and bees gradually became domesticated. About the year 1300 there were ninety-two bee farms in and around twenty-seven villages in the neighbourhood of Nuremberg. Bee-keepers were under the protection of the law, and had to pay a special money tax to the authorities or its equivalent in honey.

Bee-keeping was especially important as honey was the only sweetening stuff. Besides wine, sour honey water, called "met," was much in favour, and was exported to Constantinople and Palestine. Beeswax was the only material used for making candles for the church. It was also used for wax writing tablets, plasters, etc. A swarm of bees commanded a high price at that time, as it is known from an ancient document that a beehive was sold for three gulden while a cow cost only five gulden.

Later, about the middle of the sixteenth century, with the clearing of the forests and the cutting up of the wooded tracts into farms, bee-keeping began to lose its importance as an industry. Honey was imported from abroad, "met" was replaced by beer (the districts of important "met" production became the centres for beer-brewing), and other sweetening stuffs, such as cane sugar, were introduced.

It is estimated that the present yearly production of honey and wax in Germany has a value of £1,000,000 to £1,400,000. The following table shows the number of beehives and their value, according to the census of December 2nd, 1912:—

Districts.	Number.	Value.
		£
Silesia	188,169	232,800
Prussia	1,509,586	1,383,100
Total for all Germany.	2,636,337	3,180,000

According to the *Statistische Jahrbuch für den Preussischen Staat*, published in 1915, £1,200 was transferred from the general fund for the promotion of agriculture to the Silesian bee-keepers in 1913, as against £2,100 to East Prussia and £40 to the Rhine Province.

German apiarists keep their bees in wooden hives of different kinds. The enlargeable wooden hive with movable combs and separate parts for breeding and storing purposes are preferred now. To make bee-keeping more profitable, reports the late United States Vice-Consul at Breslau, it has been suggested that bee-keepers travel with their hives to districts of good meadows and few bees. Cheap freight rates are granted to apiarists, and it is known that every year about 375,000 beehives are transported in special trains to the heaths near Luneberg and Oldenburg.

Special "wandering carts" have been invented which have a row of hives on either side, the space in the middle of the cart being used to store separators and other necessary equipment. These carts are mounted on four wheels and are drawn by men or horses.

Bee-keepers complain of the competition of cheap foreign honey, artificial honey, and honey powders, which are sold at very low prices. (At the present time about two hundred factories are manufacturing artificial honey and honey powders in Germany.)

The bee-keepers have their own societies

throughout the country and hold regular meetings. In 1914 it was decided to unite all societies in one large union, with branches throughout Germany. The general union has suggested that a law be enacted which protects bee-keepers against the competition of foreign honey of inferior quality. They also want to propose a law against "foul brood," such as already exists in some other countries.

For the benefit of bee-keepers the society established a bee garden at Koenigsberg, East Prussia, with the assistance of the Government. This garden serves also for experimenting.

There are insurance companies for the bee-keepers, one of which is very popular in North and Middle Germany. Beehives are insured at three pfennigs per hive per year.

The following table shows the quantity of honey and artificial honey imported into Germany during the first six months of 1913 and 1914 and the chief supplying countries:—

Imported from	January to June. 1913.	1914.
	lb.	lb.
United States	449,082	406,756
Hawaii	337,748	210,762
France	358,030	212,084
British West Indies	210,762	266,098
Chile	579,154	647,498
Cuba	1,477,538	1,699,323
Dominican Republic	197,965	229,281
Mexico	294,758	276,459
Haiti	269,184	528,017
Other countries	199,509	408,237
Total quantity imported	4,373,730	4,884,515
Total value	£55,300	£61,800

Exports of German honey and artificial honey amounted to 2,615,100 lb. in the first six months of 1913, and to 2,445,124 lb. in January to June, 1914.

The exports of German wax and empty combs which went mainly to Austria-Hungary and Russia totalled 1,637,373 lb. and 2,456,368 lb. during the first six months of 1913 and 1914 respectively.

The following table shows the imports into Germany of the crude wax of bees and other insects, and of combs without honey during the first half of 1913 and 1914, and the principal countries of origin:—

Imported from	January to June. 1913.	1914.
	lb.	lb.
France	54,013	50,486
Great Britain	60,848	14,550
Italy	126,766	66,800
Netherlands	18,298	14,330
Austria-Hungary	36,817	74,296
Portugal	144,844	309,308
Spain	108,027	129,191
Turkey	55,777	84,437
Abyssinia	285,058	412,044
British East Africa	56,659	35,054
German East Africa	204,809	317,245
Madagascar	233,469	358,912
Morocco	80,248	93,917
Portuguese East Africa	138,891	145,726
Portuguese West Africa	111,994	153,442
British India	231,926	311,513
Brazil	66,359	138,009
Chile	72,532	19,842
Cuba	209,219	149,253
Dominican Republic	205,471	153,883
Total quantity imported	2,545,875	3,219,608
Total value	£170,600	£215,700

Honey imported in beehives with living bees—brought chiefly from the Netherlands—amounted to 6,393 lb. in the first six months of 1913, and to 19,180 lb. during the like period of 1914.

There are numerous ways of separating the honey from the comb, but the centrifugal process is considered the most satisfactory and practical, as the honey won by this method is pure, being free from other ingredients, and the empty combs with the frames may be used again. This particular honey is known as "Schleuderhonig," and ordinarily retails at a shilling a pound.

The present price of honey is about three shillings a pound. This extraordinary increase in price is mainly due to the very poor honey harvest of the spring and summer of 1915 and 1916, and to a falling-off in imports.

THE CHINESE TEA TRADE

Efforts are being made in China to restore the country to the position which it formerly held as the chief source of the world's supply of tea, and to this end an agricultural commission has been established having for its main object the betterment of the tea trade. The American Consul at Hankow gives some particulars of the plans for improving the industry. The first step in this direction was taken in 1905, when an investigating committee was sent to India and Ceylon in order to study the methods practised by the tea growers in those countries. As a result of this movement a school was established at Nanking, where the latest methods of tea culture were taught. In 1915 Chow Tsz-Chi was appointed Minister of Agriculture, and during his short directorship he succeeded in giving the agricultural industries of the country a tremendous impetus. His plans for improving the tea industry consisted of the establishment of experiment stations, the subsidising of certain tea planters, and a reduction in the export duty on the product. In connection with the first of the above plans, a station was established in the famous Keemun district in the Province of Anhui, where the growing of the tea plant under scientific methods is now being demonstrated to the planters of that region. It is proposed that sub-stations in the same district be rapidly established under the leadership of Chinese who have demonstrated their knowledge of modern methods of tea culture. As soon as the growers of this particular region have been made thoroughly acquainted with the new work the stations will be transferred to other tea-growing districts, where the process will be repeated. It is also planned to subsidise certain planters who have demonstrated their knowledge of tea-growing under the methods prescribed by the Department of Agriculture, in order that they may be given substantial encouragement toward carrying the work forward. Lastly, a 20 per cent. reduction in the export duty on tea was put into effect during 1915. While this step materially aided the growers, the Chinese Government, states the report, will have to take further action along this same line in order that Chinese tea may meet the competition of Indian leaf, for in India there is no tax on either the production or the exportation of tea. The Chinese grower is under the further burden of having to pay a series of transit taxes, which are levied on the article from the place of production to the place of shipment. These taxes often amount to more than the original export tax. It is thus evident under what great disadvantages the Chinese producer works as compared with his Indian neighbour. When these plans, which are excellent in conception although not entirely comprehensive, have been put into effect, together with the improvements which naturally follow the working out of any new order, it is hoped that China will at last be on the road towards regaining its position as the main source of supply for the tea trade of the world.

GENERAL NOTES.

New Zealand and the War.—According to the *Colonial Journal*, while the actual quantities of raw materials and foods exported from New Zealand in 1915 were less than in 1914, the prices fetched were £4,254,229 more—about £4 per head of population. This shrinkage of quantity and enhancement of value was still greater in 1916. The first quarter of this year, however, saw a diminution of the value of exports, due to the shipping problem.

Industrial Development in Japan. — The following particulars are taken from some notes by the British Consul-General at Tokio, published in the *Board of Trade Journal*. The iron industry in Japan, although in its infancy, gives promise of assuming considerable importance in the future. Before the war Japan produced annually 260,000 tons of iron, about one-half of its consumption. During the period under review several new companies have been formed for the production of iron, and among them six companies, with a combined capital of 40,000,000 yen, have erected new works. With regard to steel, three new companies have commenced operations, and have established four new works. One company is producing steamer shafts, railway wheels and tyres, as well as supplying the home trade. It seems to be the intention of this company to devote its energies to the export trade rather than the home market. Five new companies for the treatment of zinc ore have been organised, and it is expected that a large export trade will be carried on after the war. In the textile industry, eleven new companies, operating fourteen factories, have been formed.

Trade of Ceylon. — A Colonial report just issued shows that the total value of Ceylon's trade in 1916, excluding specie, amounted to Rs. 521,280,838, as compared with Rs. 449,550,045 in 1915, which was till then the record year. Previously the United Kingdom was well ahead of the British possessions and foreign countries in her share of the trade; now her position is only slightly better, the change being due, first, to larger exports of rubber and plumbago to foreign countries, especially the United States, and next, to increased imports from Japan and America. The percentages in 1916 were: With the United Kingdom, 35·64; with British possessions, 31·83; with foreign countries, 32·53. The value of the plumbago exports was 225 lakhs of rupees as compared with 79 lakhs of rupees in 1915. The value of the

rubber exports was almost equal to that of tea. Estimated on the basis of the Census in 1911, the population of the island (exclusive of the military and shipping) at the end of 1916 was about 4,547,200, an increase of nearly 122,900 in the twelve months. To every hundred females there are one hundred and thirteen males. In England and Wales the proportion is ninety-four.

SUEZ CANAL TRAFFIC IN WAR TIME.—The returns of the navigation through the Suez Canal for 1916 have been issued in a White Paper (Cd. 8591). The number of vessels which passed through the canal during the year was 3,110, of which 2,388 carried the British flag, against a total of 3,708 in the previous year, the net tonnage for the year showing a decrease of 2,940,808 as compared with that of the preceding year. The tonnage of German vessels decreased from 3,352,287 in 1913 to 2,118,946 in 1914, and disappeared entirely in 1915 and 1916. Troops carried through the canal numbered 235,441, as compared with 119,812 in 1915, and the number of civilian passengers amounted to 45,743—a decrease of over 40,000 compared with the preceding year. For the half-year ended June last the total traffic was 4,257,000 tons, as compared with 10,344,675 in the corresponding period of 1914. The net diminution of tonnage for this period, as compared with the previous corresponding half-year, amounted to 2,000,924, the reduction in commercial shipping being 2,121,801 tons, against an increase of 120,877 tons in ships used by the Italian, Greek, and Japanese Governments for military purposes.

ALIENS AND BRITISH OILFIELDS.—Regulation 30bb of the Defence of the Realm Regulations has been amended so as to prohibit, without the consent of the Board of Trade, the transfer to an alien or a foreign controlled company of any interest in an oilfield. A further amendment provides that the mines mentioned in the regulation shall be "mines wherever situated," and not "mines situated in Great Britain."

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 19... Engineers, Society of, at the Geological Society, Burlington House, Piccadilly, W., 5 p.m. Mr. R. Brown, "Sewage and its Precipitation: further Experiments."

Geographical Society, Kensington-gore, W., 5 p.m. Mr. E. C. Barton, "Sandbanks and Deltas."

TUESDAY, NOVEMBER 20.. Swiney Lecture, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Professor J. S. Flett, "The Mineral Resources of the British Empire." (Lecture IV.)

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. H. Dalton, "The Oil Prospects of the British Isles."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m.

University of London, University College, W.C., 5 p.m. Professor S. D. Adshead, "Housing Problems after the War." (Lecture III.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Sir Robert R. Gales, "The Hardinge Bridge over the Lower Ganges at Sara."

Anthropological Institute, 50, Great Russell-street, W.C., 5 p.m. Miss M. A. Murray, "Witch Sacrifices."

Zoological Society, Regent's-park, N.W., 4 p.m. 1. Mr. S. Alpheraky, "Deformity of *os penis* in a *Phoca caspica* Nilsson." 2. Lieut.-Col. J. M. Fawcett, "Notes on a Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911-13." 3. Mr. S. A. Neave, "Exhibition of Lantern-slides illustrating the scenery of different regions of Africa, with remarks about the characteristic fauna." 4. Professor J. P. Hill, "The new-born Marsupial and its mode of birth, illustrated by lantern-slides." 5. Professor E. W. MacBride, "The Development of *Echinocardium cordatum*." 6. Messrs. J. J. Joicey and G. Talbot, (*a*) New South American Rhopalocera; (*b*) New South American Arctiidæ; (*c*) New Butterflies from Africa and the East; (*d*) Gynandromorph of *Papilio lycophron* Hbn; (*e*) Three Aberrations of Lepidoptera.

Colonial Institute, at the Royal Society, Burlington House, W., 4 p.m. Colonel H. E. Rawson, "The Sun as Empire Builder."

WEDNESDAY, NOVEMBER 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 30 p.m. Opening Meeting of the 164th Session. Address by Mr. Alan A. Campbell Swinton, "Science and its Functions."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Meteorological Society, 70, Victoria street, S.W., 5 p.m. 1. Dr. G. C. Simpson, "The Twelve-Hourly Barometer Oscillation." 2. Mr. W. W. Bryant, "Abnormal Temperature, with special reference to the daily Maximum Air Temperature at Greenwich."

Geological Society, Burlington House, W., 5.30 p.m. Mr. J. Morrison, "The Shap Minor Intrusions."

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Messrs. E. Heron-Allen and A. Earland, "On some Foraminifera from the North Sea, etc. V.—On Thurammina papillata, Brady: A Study in Variation." 2. Mr. F. M. Duncan, Exhibition of Lantern-slides in illustration of his paper read at the last meeting.

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Dr. D. F. de l'Hoste Ranking, "The Graal Legend: some Interpretations and a Suggestion."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Hon. Sir Arthur Stanley, "Red Cross Work under War Conditions."

THURSDAY, NOVEMBER 22...Swiney Lecture, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Professor J. S. Flett, "The Mineral Resources of the British Empire." (Lecture V.)

Royal Society, Burlington House, W., 4.30 p.m.

Camera Club, 17, John-street, Adelphi, W.C., 8.15 p.m. Mr. L. J. Steele, "Mountaineering with a Camera."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. T. M. Hunter, "Gas Firing Boilers."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Dr. J. Newton Friend, "The Corrosion of Iron and Steel with special reference to Reinforced Concrete."

FRIDAY, NOVEMBER 23...Swiney Lecture, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Professor J. S. Flett, "The Mineral Resources of the British Empire." (Lecture VI.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

CONTRIBUTIONS TO THE READING-ROOM.

The Council have to acknowledge, with thanks to the Proprietors, the receipt of the following Transactions of Societies and other Periodicals.

TRANSACTIONS, ETC.

Aeronautical Society, Journal.
African Society, Journal.
American Academy of Arts and Sciences, Proceedings.
American Chemical Society, Journal.
American Institute of Architects, Journal.
American Institute of Electrical Engineers, Transactions.
American Institute of Mining Engineers, Transactions.
American Leather Chemists' Association, Journal.
American Philosophical Society, Proceedings and Transactions.
American Society of Civil Engineers, Transactions.
American Society of Mechanical Engineers, Journal.
Amsterdam, Koloniaal Instituut, Bulletin.
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Auctioneers' and Estate Agents' Institute, Record.
Australasian Association for the Advancement of Science, Report.
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Bagnères-de-Bigorre, Société Ramond, Bulletin.
Barrow and District Association of Engineers, Transactions.
Bath and West of England Society, Journal.
Bombay, Royal Asiatic Society, Journal.
British Association for the Advancement of Science, Report.
British Dental Association, Journal.
British Fire Prevention Committee, Publications.
Canada, Royal Society, Proceedings and Transactions.
Canadian Society of Civil Engineers, Transactions.
Central Chamber of Agriculture, Journal.
Chartered Institute of Patent Agents, Transactions.
Chemical Society, Journal.
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East India Association, Journal.
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Institution of Naval Architects, Transactions.
Institution of Petroleum Technologists, Journal.
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Lyons, Société d'Agriculture, Sciences et Industrie, Annales.
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———, Municipal School of Technology Journal.
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Milan, Associazione Elettrotecnica Italiana, Atti.
———, Collegio degli Ingegneri ed Architetti, Atti.
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Royal Institution of Great Britain, Proceedings.
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Royal Meteorological Society, Quarterly Journal and Record.
Royal National Life-Boat Institution, "The Life-Boat" and Annual Report.
Royal Sanitary Institute, Journal.
Royal Scottish Society of Arts, Transactions.
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Royal United Service Institution, Journal.
St. Louis Engineers' Club, Journal.
Smithsonian Institution, Report and Publications.
Society of Antiquaries, Archæologia and Proceedings.
Society of Architects, Journal.
Society of Biblical Archæology, Proceedings.
Society of Chemical Industry, Journal.
Society of Dyers and Colourists, Journal.
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South African Association for the Advancement of Science, Report.
South Wales Institute of Engineers, Proceedings.
Tokyo, Imperial University, Journal of the College of Science.
Tramways and Light Railways Association, Journal.
Victoria Institute, Journal of the Transactions.
Washington, National Academy of Sciences, Proceedings.
Wisconsin Academy of Sciences, Transactions.

JOURNALS.

Weekly.

Amateur Photographer.
American Gas Light Journal.
American Machinist.
Architect.
Auto-Motor Journal.
Board of Trade Journal.
Bradstreet's.
British Journal of Photography.

Builder.
Building News.
Cabinet Maker.
Chemical News.
Chemist and Druggist.
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Contractors' Record.
Economist.
Electrical Industries.
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Flying.
Gardeners' Chronicle.
Grocer.
Indian Engineering.
Iron and Coal Trades Review.
Journal of Agricultural Research (Washington).
Journal of Gas Lighting.
Lancet.
Leather.
London County Council Gazette.
London Teacher.
Machinery.
Machinery Market.
Mechanical World.
Medical Press and Circular.
Mining Journal.
Model Engineer and Electrician.
Motor Traction.
Musical Standard.
Nature.
Page's Weekly.
Pharmaceutical Journal.
Photography.
Pitman's Journal.
Practical Engineer.
Produce Markets' Review.
Public Opinion.
Pulp and Paper Magazine of Canada.
Sanitary Record.
Saturday Review.
Science.
Scientific American.
Shipping World.
Spectator.
Surveyor.
Syren.
Textile Mercury.
Work.

Fortnightly.

Agricultural News (Barbados).
Dyer and Calico Printer.
Finance Chronicle.
Jeweller and Metalworker.
Junior Mechanics and Electricity.
Madrid Cientifico.
Perak Government Gazette.
Revue Générale des Sciences.
West India Committee Circular.

Monthly.

Acetylene Lighting and Welding Journal.
American Photography.
Analyst.
Arms and Explosives.
Automobile Engineer.
Board of Agriculture Journal.
Bookseller.
Brewers' Journal.
British Esperantist.
British Trade Journal.
Cassier's Engineering Monthly.
Chamber of Commerce Journal.
Cold Storage and Ice Trades Review.
Commercial Education.
Co-partnership.
Cotton (Atlanta).
Decorator.
Educational Times.
Engineering Review.
Gas and Oil Power.
Geographical Journal.
Geographical Review (New York).
Giornale del Genio Civile (Rome).
Horological Journal.
Ice and Cold Storage.
Illuminating Engineer.
Imperial Colonist.
Industrial Management (New York).
International Sugar Journal.
Investor's Monthly Manual.
Leather Trades' Review.
Marine Engineer.
Master Builder.
Mercantile Guardian.
Miller.
Mining Magazine.
Moniteur Scientifique.
Musical Times.
Mysore Economic Journal.
Notes and Queries.
Paper Maker.
Paper Makers' Monthly Journal.
Philosophical Magazine.
Photographic Journal.
Plumber and Decorator.
Popular Science Monthly (New York).
Pottery and Glass (New York).
Pottery Gazette.
Power User.
Propriété Industrielle (Berne).
Science Abstracts.
Scottish Geographical Magazine.
Secretary.
Steamship.
Studio.
Symons's Meteorological Magazine.
Textile Manufacturer.
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Water and Water Engineering.
Wireless World.

Quarterly.

Agricultural Journal of India.
Botanical Journal.
Colonial Journal.
Edinburgh Review.
Quarterly Review.
West Indian Bulletin.

NEWSPAPERS.

Canadian Gazette.
Ceylon Observer (Overland Edition).
Englishman (Calcutta).
Home and Colonial Mail.
London and China Telegraph.
London Commercial Record.
Madras Weekly Mail.
Newcastle Weekly Chronicle.
Pioneer Mail (Allahabad).
South Africa.
Times of Ceylon (Weekly Summary).
Times of India (Overland Weekly Edition).

The issue of many of the Publications formerly received by the Society has been interrupted by the War, and their names have been temporarily removed from this list.

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